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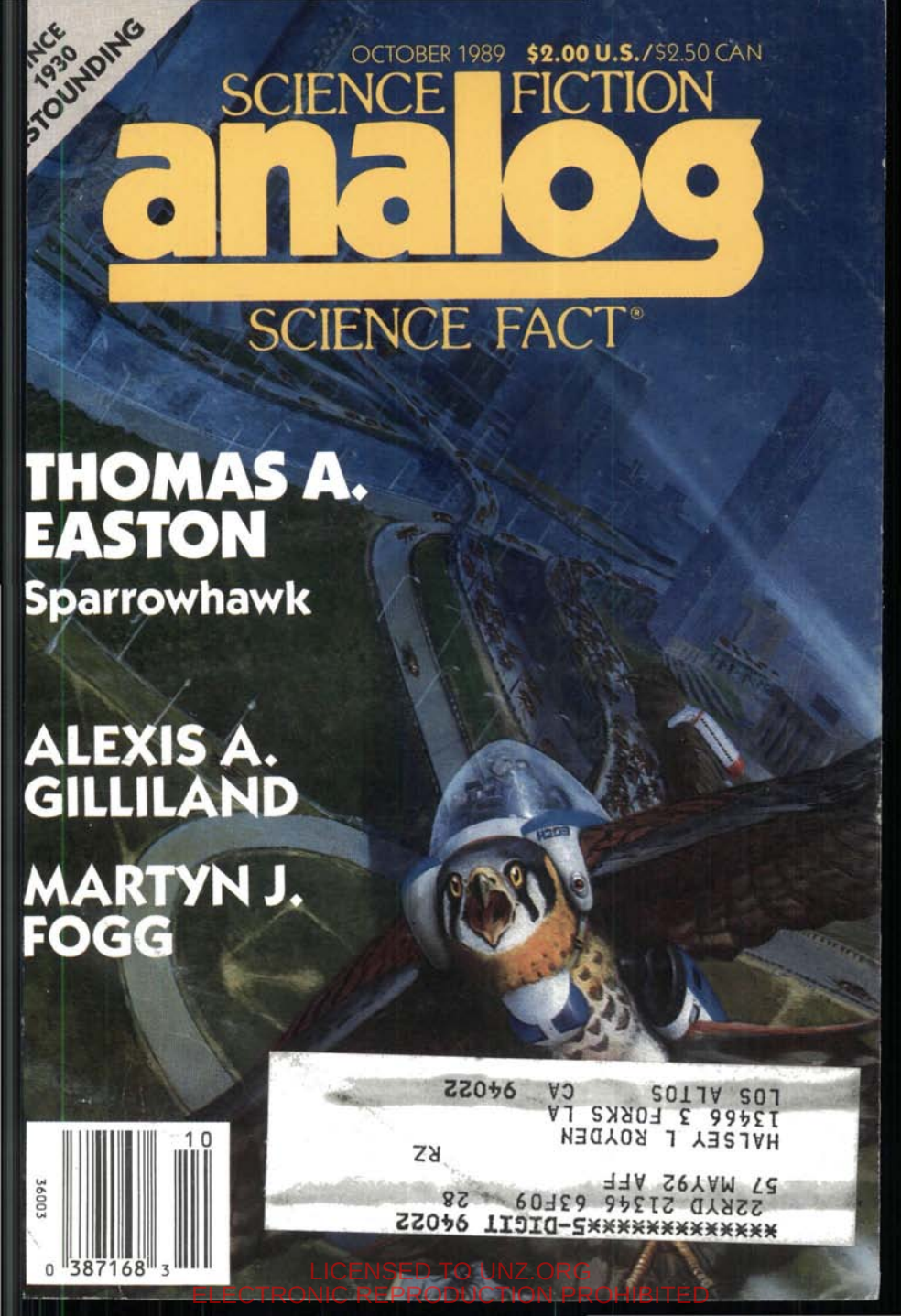

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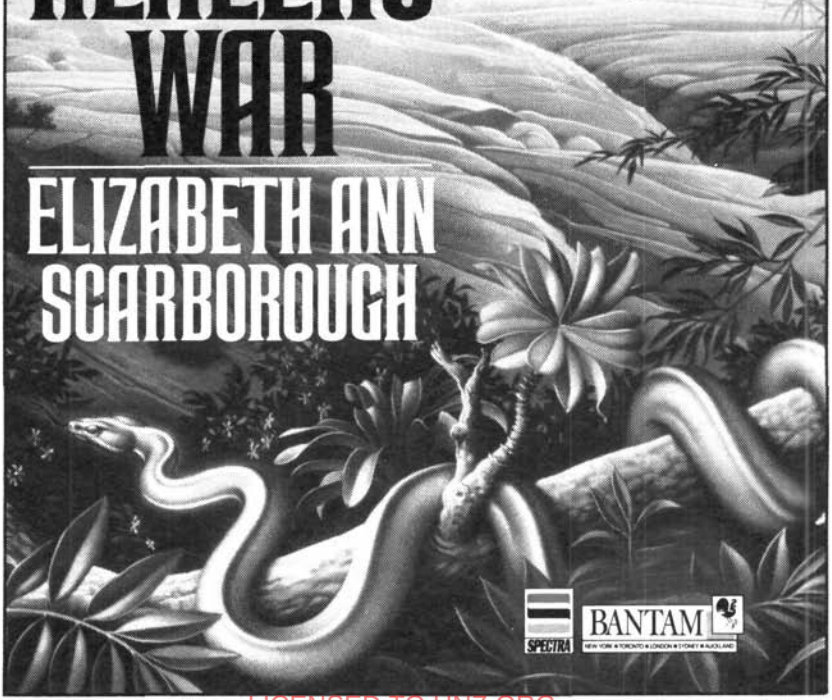

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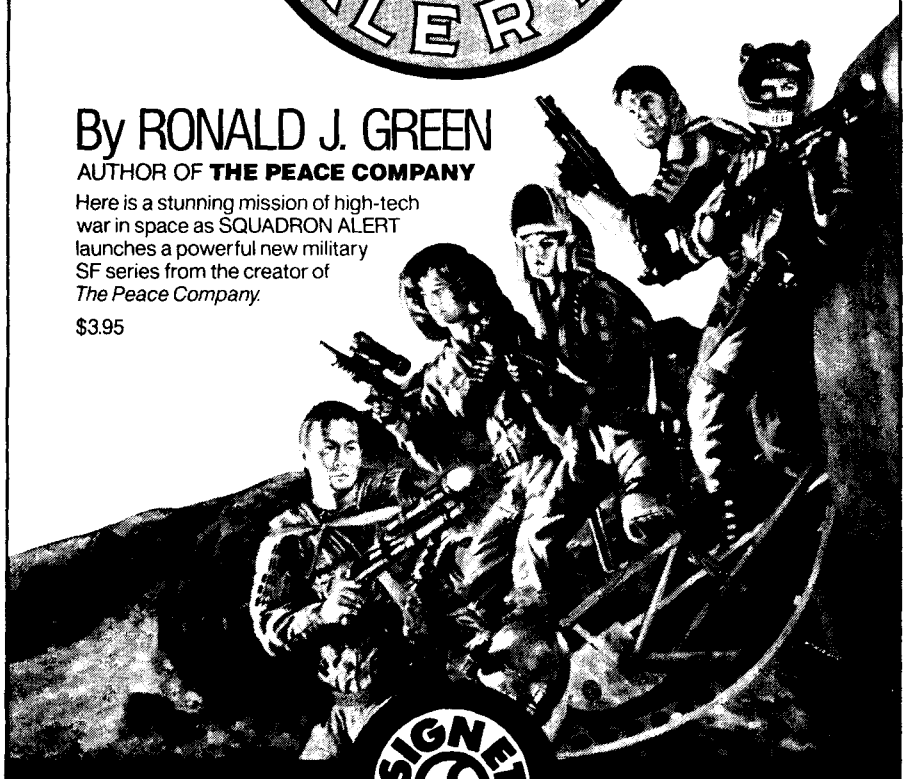

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Editorial

THE LIMITS OF TOLERANCE

Stanley Schmidt

When you consider the head start religion itself has in getting a grip on human minds and emotions, the concept of religious tolerance seems one of the more remarkable accomplishments of civilization. Rather than being shocked when either individuals or institutions display *in*tolerance, perhaps we should be surprised that it doesn't happen still more often. After all, to truly devoted believers in *any* religion, that body of beliefs constitutes nothing less than the most important truth in the universe. Why *should* they tolerate disbelief or contradiction? To tolerate different beliefs in others would seem to require admitting either (a) that there is room for doubt about the validity of the beliefs; (b) that the subject of the beliefs is not very important, so it doesn't matter what people think; or (c) that other people can hold different beliefs from mine without endangering me, and I am not responsible for the trouble they're risking with my deity or deities.

Options (a) and (b) are untenable for any true believer, and nonbelievers need to realize just how literally true that is if they are to have any hope of achieving understanding with people of faith. These are matters *beyond* life-and-death importance. If you know the ultimate truth about life, the Universe, and everything, why should you tolerate behavior which is obviously *wrong* by those who haven't been enlightened? If you're in that position, option (c) may

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seem downright irrational. Religious tolerance probably tends to come easiest to people who are not particularly religious themselves, since they can easily accept options (a) or (b). For devout believers, no matter in *what*, things aren't that simple.

The problem is, as Mark Twain said, "Man is the only animal with the True Religion—several of them." What do you do when you have lots of groups, each of which believes it has the ultimate truth, but none of which can prove its version's validity in a way satisfactory to the others? They *can't* all be completely and literally right, since they contradict each other in at least some particulars—and particulars that look trivial to an outsider may be of the utmost importance to the doctrine of a particular sect.

The solution is tolerance. In many parts of the world, tolerance of other faiths (or lack of faith) has gradually come to be regarded as a hallmark of civilized behavior. It would be tempting, but naïve, to assume that this has come about through the widespread and rational recognition that since none of the religions can present objective proof of its beliefs, each should give others the benefit of the doubt. It seems far more likely that the real cause is a pragmatic recognition that it's usually impossible to convince anyone else of the validity of any faith but his own—and it's dangerous to try (unless you're bigger than he is). We've all seen plenty of demonstrations that devotees of some religions would love to convert everyone else to their own beliefs, if they could. Most don't try terribly hard because they've learned that while they're trying to convert others, someone else may try to convert *them*, with potentially lethal results. Religious tolerance has evolved as a peacekeeping device, to enhance everybody's chances of survival.

But exactly what does "tolerance" mean, and how far should it extend? Does it mean merely that religious groups should be free to live according to their own faiths' teachings, without interference from other religious groups or political authorities? Does it mean that no one, within or outside a particular religion, should be able to criticize or question any of its beliefs? Whatever the level of protection extended to religions and their adherents, must it be applied categorically to *all* religions, or might some exceptions be justifiable or even necessary?

What, if any, are the limits of tolerance?

The automatic response, among people who think of themselves as open-minded and virtuous, is likely to be an indignant, "None! No limits or exceptions to tolerance can be tolerated!" It's an easy position to defend, and even to sincerely believe, as long as no one's feathers are being ruffled. But when they *are* being ruffled, and more . . .

It's fairly easy for most of us to admit that the forms of worship used inside somebody else's church—for example, whether instrumental music is allowed in services—is no legitimate concern of ours. (It's even easier to admit that what

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goes on in *ours* is no business of *theirs*—and some of us are fortunate enough to understand that it works both ways.) Most of us can accept, and perhaps even admire, a religious group whose members form a self-sufficient community that maintains its own ways and shuns those of the larger culture that surrounds it—as long as they don't bother anyone else.

But what about a religious leader who persuades hundreds of disciples to follow him into an isolated community and then commit mass suicide in the name of faith? What about religious leaders who use political and economic pressure to dictate what should be taught in public schools, not just to their own children, but to everybody else's? Or people who use the tenets of their faith to justify bombing clinics where people who don't share that faith go for medical proce-

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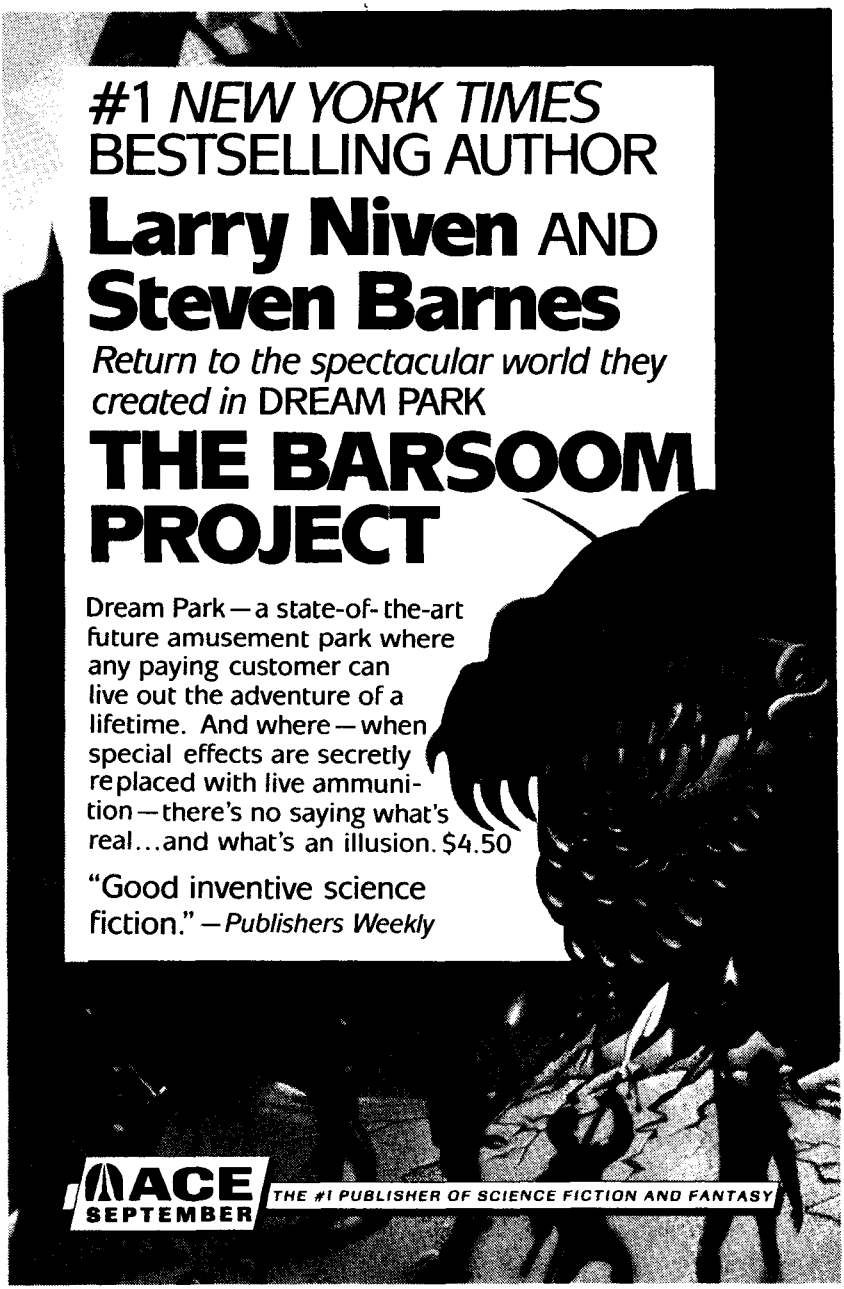

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dures which are not forbidden by either the *patients'* religions or the law of the land? What about those who demand that a movie be banned because they find it offensive to their own religious standards? Or even urge their followers, with the promise of both earthly and heavenly rewards, to murder the author of a book they find offensive—along with anybody involved in publishing and distributing it?

All of these things have happened in recent memory. All of them have seemed to a great many men and women of intelligence and conscience to go well beyond reasonable and proper "freedom of religion." Such actions raise a fundamental, and understandably disturbing, question.

Must we tolerate anything and everything that is done in the name of religion, merely because it is done in the name of religion?

I think not. A fair case can be made for allowing any religious group to educate its own children as it sees fit (even though a fair case can also be made that this may sometimes be detrimental to the long-term welfare of those children). A good case can be made for the right of anyone to refuse to *have* a medical procedure which is forbidden by his or her religion. I could hardly argue with the right of anyone to avoid a movie or book he expects to find offensive; or even the right of a religious leader to forbid his followers to view, read, write, or produce such material. A member of his group who wants to remain one can follow the decree; one who finds that unacceptable can cease to be a member. (Or can he? There's at least one case on record, not many years ago, of a person who did leave the religion he grew up in, founded a new one, and was assassinated under orders from the leaders of the old. . . .)

Different standards may apply to a willing adult member of a religion and to a nonmember—as long as the option of freely becoming a nonmember exists. Most religions expect special things of their members, and the things they give in return are profoundly valuable to a great many people. Freedom of religion is freedom for any adult to agree to that exchange with any religious group he chooses—or none. That freedom needs to be protected, for people of *all* religions, as well as those not subscribing to any.

Stated thus, it allows a great deal of leeway to both individuals and religious organizations. It would seem reasonable, for example, to allow religious leaders to forbid their followers to write or read certain kinds of books, and to allow individuals to join (or leave) groups that impose such requirements. A case can even be made for allowing groups to impose quite serious penalties for violations by members, as long as they want to remain members. Excommunication is a reasonable response for a group built on a certain ideological foundation to take against one who claims to belong to that group and yet writes a book attacking or ridiculing its fundamental tenets. An official call for his murder is another matter entirely, and much harder to justify. Calling for the murder of others associated with the

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publication of his book, who never claimed to be affiliated with that religion, is way beyond "hard to justify."

It is intolerable.

Please note: I have said nothing, and do not intend to say anything, about the merits or faults of any books or movies which have prompted such actions. Chances are I haven't seen them, and their merits or faults are irrelevant to my argument. Nor am I attacking or criticizing any religion or religions. I respect everyone's right to believe anything he or she chooses to—as long as actions inspired by that belief do not infringe on people who don't share it. Furthermore, I'm well aware that the actions I've described do not represent or reflect on major religions in their entirety. They are the actions of specific individuals or subgroups within those religions, and have been explicitly disavowed and deplored by others.

I do not endorse or recommend gratuitously insulting people's religions. But the fact that I or anyone else does not practice or approve an action does not give us the right to forbid anyone else to do it. It is essential to the preservation and continued growth of civilization that *all* ideas be open to examination and discussion by anyone who wants to examine and discuss them. That means *all* ideas, not just those which have not been declared off limits by some religious group or other. Any religious group can impose such limits on its own members, and any individual can agree to accept them. But religious groups must *not* be allowed to impose such limits on anyone *except* willing

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members, or to demand that anyone else observe them.

Vandalism and murder are vandalism and murder, no matter how piously they may be performed. Neither has any place in a civilized society, whether it is done by a garden-variety thug or by a widely recognized religious leader. Freedom of religion is important and needs to be preserved. But it must be clearly understood that that freedom applies only to what is done *inside* a religion. As soon as a religious group takes actions which affect people outside it, those actions must be subject to the same limitations as if they were done by any private citizen.

And those limits have been succinctly summarized in a well-known old saying: "Your freedom to swing your arm stops where my nose begins."

Even for religions. ■

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SPARROWHAWK

Thomas A. Easton

(part I)

Biological machines have a lot of advantages over other kinds. But engineered animals are still animals, and people are still people. . . .

Nicholas Jainschigg

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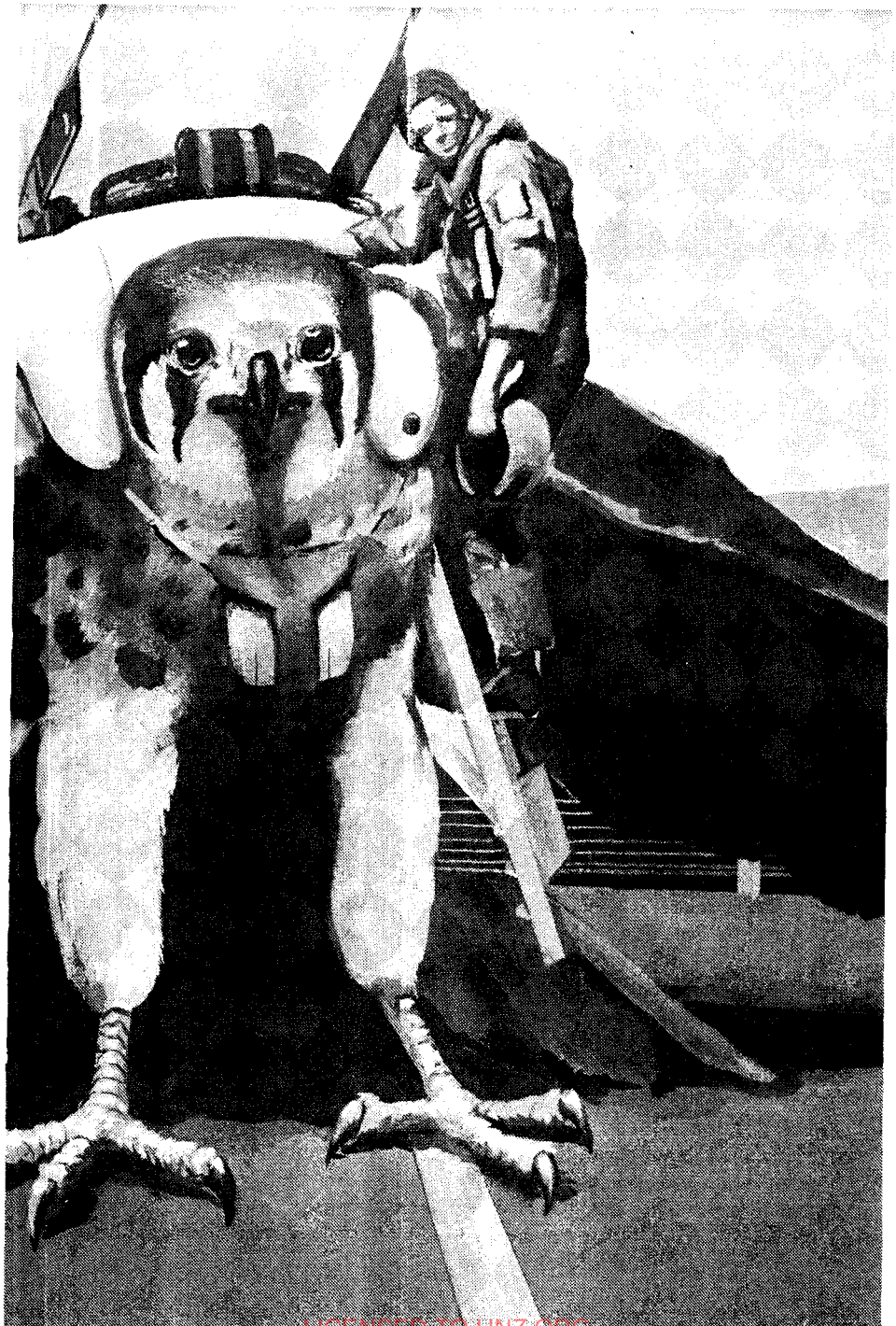

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Five-year-old Andy Gilman was kneeling on a chair by the kitchen window. Half a dozen plastic Warbirds were scattered on the floor beneath him. With the tip of one finger, he was writing his name in the large smudge his nose had left on the glass. Suddenly, he stiffened and pointed beyond the pane. "Look, Daddy!" he cried. "See the bird! By the feeder! A big one!"

Nick Gilman grinned and crossed the room in a stride. He looked, and the kid was right. A Chickadee, the size of an old-fashioned Piper Cub, was on the lawn beside the back porch. It wasn't wearing its two-seater passenger or engine pods. As Nick watched, it cocked its head to one side, inserted its beak between the shelf and the overhanging roof of the feeder, and seized a mouthful of seeds. Then, shaking its head as if the treat had been more effort than it was worth, it stepped back a pace.

As it did so, nongengineered birds of more normal size approached to try to reach the seeds remaining in the feeder. Few succeeded, for as they fluttered past the Chickadee, they fell prey instead to its darting beak. Nick shuddered, remembering when all chickadees had been vegetarians. "C'mon, Andy. We're in a rush. Gotta go get Mommy."

"But Daddy! I wanna watch!"

Nick had no time for nonsense. Emily's jet would be late, of course, but it was due in an hour, and he had to be there just in case she was on time or—God forbid!—early. He should have left ten minutes before, but the casserole had needed its finishing touches and he had had to adjust the oven and he had had to run a comb through his hair and he had had to straighten the throw rug that had slid beneath his feet and . . . It wasn't easy being a househusband.

The radio began to mutter that, on this hot and muggy Tuesday in July of 2044, terrorist attacks were becoming more frequent, but he had no time to listen. Nor did he care to think of what such a thing might mean for Emily, or him, or their tow-headed son. He turned it off and grabbed his jacket. Then he picked the boy up in his arms, wiped the snot from his nose with a handkerchief, and rushed from the room.

Emily would be back soon from her Washington trip; he loved her dearly, and he didn't want to leave her waiting. Sometimes he wished their roles were reversed, with him the one wandering the world on high adventures and she the one at home. But his doctorate in Romantic Poets meant he was virtually unemployable.

Nick had opened the garage door that morning and led the Tortoise out for relief from the heat. Now the family vehicle was waiting in the drive, shaded by nearby trees. Nick had bought it when he was in college and single. It had been young then, with the passenger compartment in the shell just big enough, in a squeeze, for two. It had grown since then, maturing from the sportscar stage to coupe. Eventually, timed by gengineers like Emily to match a family's growth, it would gain the capacity of a station wagon.

As Nick and Andy left the house, the Tortoise's barrel-like head turned toward them. The legs on the side facing the house flexed. Nick stepped onto the offered lip of shell, resembling an old-time running board, and opened the door. Andy scooted across the bucket

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seats to let his father take his position behind the tiller.

Even before the door clicked into its frame, the Tortoise's knees were rising and falling, piston-like, in Nick's peripheral vision. He steered it onto the greenway that had long since replaced paved streets in his suburb, guided it toward the expressway on-ramp, and accelerated. The Tortoise's knees became a blur, its breathing an audible gale of wind.

The expressway itself was still paved. The Public Works Department kept promising to have it grassed, for almost all vehicles were now bioforms, or genimals. But public money was as short as ever, and the Biological Revolution was still new. Many residential neighborhoods, unlike Nick's, also still had paved streets. Only a few neighborhoods had yet gone to modern bioform houses, gengineered from pumpkins, squash, beanstalks, eggplants, and even more exotic stock.

Air transportation was somewhat more advanced. As Nick and Andy neared the airport, they passed a zone of bedraggled hangars and paved runways. Airplanes—Comanches, Beechcrafts, Boeings—stood about in varying states of dishabille. A few showed the faded, painted-over logos of major airlines. Most wore nothing but their serial numbers.

"What's that, Daddy? Jets?" To him, the gengineered birds were the normal technology. These were strange variants, stiff and featherless, emblems of a realm set askew from the world he knew, but oddly reminiscent of it.

"Obsolete junkers, Andy." The traffic had been light, they would be there in plenty of time, and Nick had relaxed. He spared a glance for the display beside the expressway. "Real airplanes. They used to carry people. Now it's just cargo."

Their Tortoise sped them past another airport zone. The runways were still paved, but the hangars were in better shape and the planes wore shiny coats of paint. "Hobbyists," said Nick. "Weekend flyers." One of the planes was a bulb-nosed giant, towering above all the others. On its tail was a stylized rabbit head.

"How do they fly?"

"They have engines, just like the jets. On the wings." He pointed. "And propellor engines, in the nose. And see the windows up front?" When Andy nodded, Nick added, "People drive them, like the old-time cars." He paused. "I took a few lessons once. On a small one."

The terminal loomed ahead, all glass and steel and concrete, with mown grass beyond. The control tower held a faceted ball above everything. Nick fantasized that some Paul Bunyan of a golfer poised to send that ball down the green runways. He pointed and said, "Fore!" Andy giggled.

Nick avoided the parking barn, searching for and finding a space in an open lot nearer their destination. Once in the air-conditioned terminal, he checked a board to find that Emily's flight would, as he had expected, be a few minutes late. Then, at Andy's insistence, they took the escalator to the observation deck.

He let Andy lead him, running, to the edge of the deck. He braced himself against the warm wind, wished that they

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had stayed inside and remained cool, peered into the sky looking for his wife, and listened to the airport noises. The boy chinned himself on the railing, imitated his father's searching gaze, and pointed into the distance.

A flight was coming in above the ranks of trees that filled in the middle distance beyond the runways. The trees had been gengineered from a tropical species to stand more northern climates. Their sap provided the fuel needed for the engines of jets and other powered vehicles.

The approaching jet was still too far away to show any detail, but they could make out the distinctive curve of the extended wings, the elevated, horizontal tail without an upright, the rounded bulge of the forepart. It came closer, and they could see the two engines mounted just in front of the tail, the fuel tanks, the passenger pod strapped to the back. Still closer, and the slate-grey upper surfaces separated from the lighter underside.

Andy cried, "That's a Junco 47!" He had a plastic model of the huge genimal hanging from the ceiling of his room at home. Perhaps inevitably, the model had a more mechanical appearance than the real thing. So had the models of bombers and airlines and Space Shuttles that had decorated Nick's childhood bedroom.

The Junco extended its feet and cupped its wings. Now Nick could make out the China Airlines logo on the side of one fuel tank. The gengineers had triumphed with the airliners, he thought. Birds, ordinary birds, had been redesigned to such extremes of size that they could no longer fly on their own. The biggest, like the Junco, even needed metal-composite implants to strenghten their skeletons. Only the smallest, like that Chickadee at home, could get into the air without their jet engines and fuel tanks, and even they needed help when they were carrying passengers or freight. Still, Nick knew, larger creatures had once flown entirely under their own power. Periodically, the press reminded the public that millions of years ago, in the age of dinosaurs, there had been a pteranodon the size of an Air Force fighter.

Emily had told him why the gengineers had bothered. Jets like the Junco needed much less in the way of the metals which cost so much to mine and process. They were more efficient and safer as well. Though they could not normally fly on their own, in emergencies they could manage a few flaps of their wings. They could control their machine-powered flight, and they needed very short runways. They were also self-building, once the gengineers were done with the design work, and self-repairing.

The landing was smooth. Nick followed Andy's pointing finger to the side, where an Alitalia Cardinal, free for the moment of its passenger pod and engines, preened its plumage. Bright red feathers littered the grass around it, most of them too big to blow in the wind.

Nearby were an American Bald Eagle, a Canadian Pacific Snow Goose, and a British Caledonian Chimney Swift, its morning-coat tails recalling the formalities of another age. A fat-bodied Wild Turkey bore the Delta logo, and Nick remembered that that was the com-

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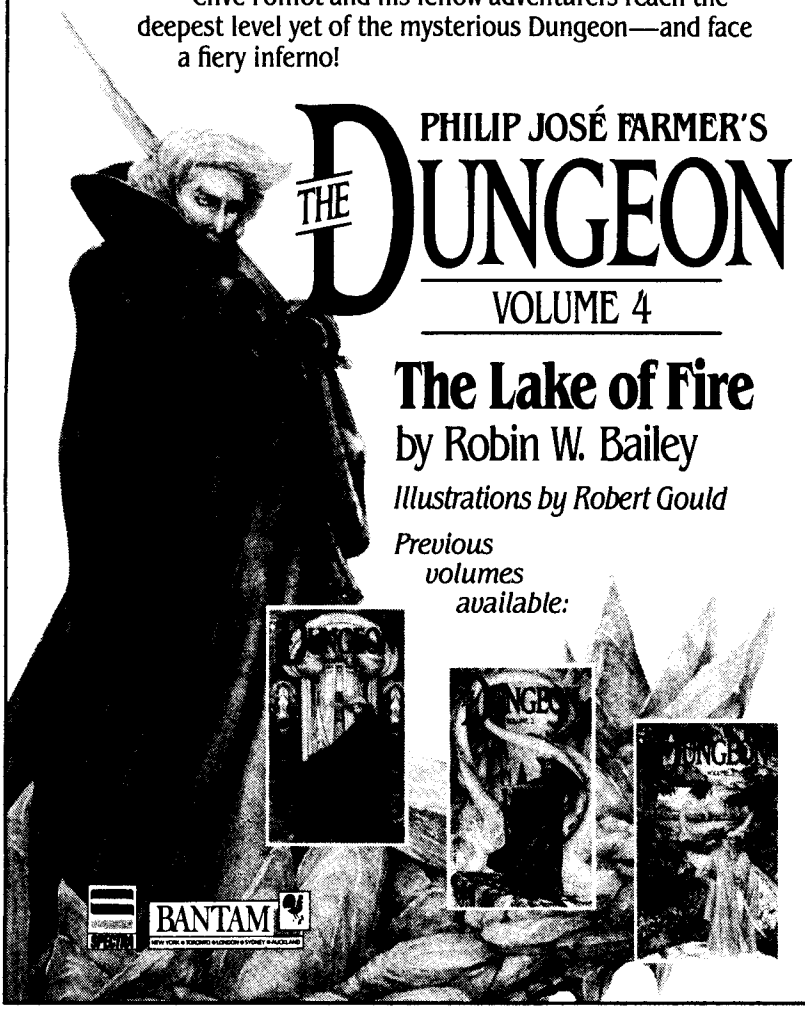

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by Robin W. Bailey

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plimentary bourbon they served on board. He and Emily had flown Delta on their honeymoon. United, with its Lovebirds, had seemed too cute to appeal to them.

"What's that, Daddy?"

"That" was a metal box much like the trailer of an eighteen-wheel semi. As the Junco 47 approached the terminal, it converged on the same destination, drawn by a squat, heavy-muscled, squash-faced creature whose rootstock had clearly been a bulldog. Its top was covered by pleats of heavy fabric, and liquid dripped from its base onto the ground.

"Watch," said Nick. The Junco was in position. As the passenger tunnel snugged its mouth, lamprey-like, against the jet's pod, the trailer drew under its nose. The ground crew turned cranks mounted on the trailer's ends, and the fabric rose on an internal frame to surround the Junco's head. The motions that promptly began to shake the fabric could not be misinterpreted. The jet's refueling was under way.

"What kind of seeds is it eating?" asked Andy. He had seen ordinary juncos in the bird feeder at home. He had even set out the sunflower seeds for them.

Nick shook his head. "Uh-uh," he said. "It's like the Chickadee. When they're this big, they have to eat meat." It was cheaper than any alternative, for it was obtained from worms and slugs gengineered to thrive on human wastes and garbage.

"See the litterbugs?" he added. The rattle of cloven hooves reached them even on the observation deck as a trio of strange-looking creatures raced toward the liner's other end from the service bay that had disgorged the feed trailer. They vaguely resembled pigs, but their limbs were longer and their snouts were distorted into broad scoops. Smaller versions patrolled city streets, seeking out and devouring the leavings of other genimals. They did not neglect banana peels, paper scraps, and beverage containers.

They did not interest Andy. The boy glanced at them briefly, dismissed them as common, and looked skyward again. Nick chuckled quietly, thinking that someday the boy might see some small, wild bird release its wastes in flight. Perhaps he would wonder, then, about the airlines. They had, Nick knew, been gengineered to discharge their wastes while feeding. Many mammals—even humans—did it without the gengineering. It was, Emily had told him once, a simple "make-room" reflex.

Andy shouted. He was pointing toward the horizon once more. In a moment, they could identify a Northwest Albatross. Once the jet was on the ground, Nick took Andy by the hand and they headed for the gate.

Emily was the third person to come striding up the ramp from the plane, grinning, eyes scanning the small crowd for her family. A slender, dark-haired woman whose wide mouth often showed its teeth in a smile that would have done justice to a veedo evangelist, she exuded alertness and energy. One hand held a garment bag and a purse over her shoulder. The other clutched a briefcase and a plastic bag from whose top protruded a few green leaves.

Nick, grinning as broadly as she, took the garment bag. She knelt then, to wrap her free arm around their son. "Ah,

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Andy," she said. "You need to blow. And look what I've got right here."

She opened the bag she carried to reveal a plant whose dark green leaves alternated with white oblongs. One of the latter she picked and held to Andy's nose. "Blow!" The boy obliged, laughed, and cried, "A hanky bush!"

"Right!" She looked at her husband. "Something new. They're working on more productive models for the bathroom and kitchen."

"That should save a few trees," he said.

Her mouth twisted into a rueful grin, and she shook her head. "It won't help the paper industry. But . . . "

She didn't need to tell him more. The technology was changing. The gengineers had already changed many industries beyond recognition. Now it was the turn of the pulp and paper industry. Yet, in the nature of things, as old jobs vanished, new ones appeared. He did not believe what some claimed, that the Biological Revolution would in time free people entirely of the need to labor. He did believe that, eventually, the labor market would stabilize and the unemployment rate would fall. Then their taxes need not be so high, and more of Emily's income could be theirs.

"Let's go," said Emily. "I want to put my feet up."

"How'd it go?" The patent hearing had concerned what she hoped would be her company's latest product, a jellyfish modified to inflate itself with hydrogen. It was the size of a blimp, and its tentacles gave it a built-in cargo-handling system.

She shook her head as she stood. Andy seized her hand. "I got some heavy interest from a van company. But no patent."

They were nearing a souvenir kiosk, and Andy was pointing at the jet feathers on display. "I wanta red one!"

Emily shrugged. "The Pentagon said they'd already grown some. Very few details."

Nick snorted and reached for his wallet. A moment later, Andy had his feather—longer than his father was tall—and their Tortoise was in sight.

The expressway never seemed so crowded as when they were on their way home. While Emily cuddled Andy and listened to him chatter about his two days alone with Daddy, Nick swore at the Roachsters and other Buggies that dawdled in front of their Tortoise, the Mack trucks that strained to keep their heavy trailers up to speed, the Hoppers that plunged past them into whatever gaps opened up in the flow of traffic, the occasional old-style automobile whose noise made the Tortoise lurch aside. It occurred to him that if he were just a little paranoid, it would be very easy to believe in some vast conspiracy of other drivers: They *knew* he was in a rush to get home, and every slowcoach, every lane-jumper, every flare of brake lights, was one more deliberate, intended effort to drive him nuts!

"Can I have a soda? Please?"

A small cooler was built into the dashboard, beside the map compartment. Emily unlatched its door and peered inside. "Ginger ale or root beer, honey. Take your pick."

"Root beer." She passed the can into the back seat, and there was near silence. The odor of root beer drifted to-

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ward the front seat, and in a moment there was a loud burp and a giggle. "That was a good one," she said.

Fortunately, for all the apparent crowd, the expressway journey never seemed so short either. Even as Nick swore and Andy drank, while the tip of his feather fluttered in the wind outside his window, Emily talked of what had gone on in Washington—the general who had wanted to classify both the patent application and the Bioblimp it described, the vice-president of Mayflower Van Lines who had asked whether Emily's lab could give the Bioblimp built-in cargo pockets, the official from the Bioform Regulatory Administration who had wanted a more detailed Environmental Impact Statement, the . . . It seemed impossible that their journey from the airport could give her the time she needed to tell it all.

She was talking about the sort of environmental impacts a giant jellyfish could have when a gust of wind sent the Hopper before them staggering and a shadow fell across the road. She craned her neck to look out her window and up. "It's a Sparrow!"

The sound of the Sparrow's jet engine swelled until it dominated the air. The shadow swept past the Tortoise, and the airliner was plainly visible. Long and sleek, the size of an old Boeing 707, its extended feet as large and stark as elm trees stripped of all but major branches and turned upside down, it did not much resemble its rootstock. But its eye had the perky ancestral gleam, and the feathers that showed on the wings and below the passenger pod were the proper streaky brown. Written along the side of the passenger pod, in both English and Arabic, was the Palestine Airways motto: "No Sparrow Falls."

The Sparrow sideslipped, swung broadside to their view, and landed in the road ahead. Its body spread across all six traffic lanes, its feet squashing a Roachster and a Hopper.

"What the—?" The brake pedal was in the traditional place, and Nick stepped on it, hard. As the Tortoise stiffened its legs and skidded toward a halt, Nick's voice rose to a shout: "What are those idiots doing?"

Emily's broad mouth hung open. She shook her head, both in disbelief and in admission that she too knew nothing about the motivations of idiots. The Tortoise slowed and stopped, as did the traffic around it. A cacophony of Buggy voices arose as traffic began to pile up and drivers leaned on their horns.

The Sparrow cocked its head, first one way, then the other, casting its eyes by turns upon the chaos it had created. Its beak thrust, and a Hopper went down its throat, in pieces, one by one. A Roachster quickly followed.

Nick swore more genuinely as he reached for the panel hiding a control he had never dreamed he would have to use. Drops of sweat appeared on his forehead. "Where. . . ? Ah."

The panel stuck, gave way to the bang of Nick's fist, and opened. He pushed the switch behind it, and the Tortoise lowered its belly-plate, or plastron, to the pavement. Then it drew its head and legs as far into its shell as possible. Unfortunately, it was not a box turtle and it could not protect itself entirely. Its nose and feet remained exposed.

The doors locked, and the windows slid smoothly all the way up, sealing the

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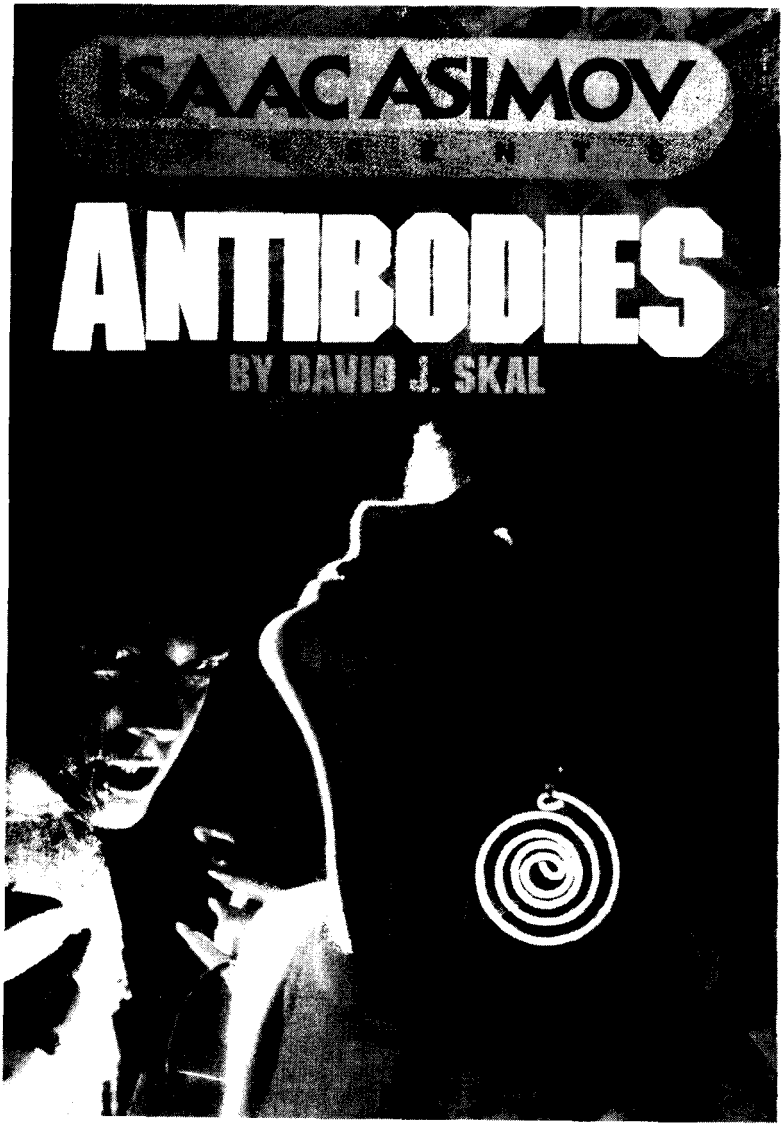

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Tortoise's passengers into as safe a redoubt as foresighted engineers could manage to provide. As a side-effect, the severed tip of Andy's jet feather fell to the pavement outside.

"Wow!" said Andy. He ignored what on any other day would have been a major disaster. His nose was plastered to the window, just as it had been at home when Nick had collared him for this trip.

The day's heat wasted no time in making itself felt. The Tortoise had no air-conditioning, and its interior quickly became intolerable despite the best efforts of the ventilation system. But they dared not leave their shelter or open its windows. Nor did they want to. Nick thought that the ventilator admitted quite enough of the metallic scent of fresh blood.

Fortunately, the carnage and the chaos outside the Tortoise were more than enough to keep their minds off their suffering inside it. Buggies struggled to reverse in the middle of the road. But the traffic jam was now too thick. A few, luckily near the shoulder, tried to use the embankment to make the turn or as a route to off-road freedom. But soon that lane too was blocked. Drivers and passengers fled their gridlocked vehicles. But nothing helped.

As soon as anyone left their Buggy, the Sparrow's eye turned their way. Split seconds later, the beak thrust, clamped down on wildly struggling limbs, and choked off screams. Few escaped successfully.

Even those who cowered within their Buggies were not safe. When the Sparrow saw no prey fleeing, it accepted the vehicles with every appearance of relish. Its ancestors had been opportunists, dining on seeds, crumbs, and insects as it found them. Now it faced a wealth of insectile creatures, all of a size proportionate to itself. Its satisfaction was obvious.

Only the few Tortoises on the road, each one pulled as much as possible into its shell, the old-style automobiles, even more hard-shelled, and the trucks, too huge, seemed immune to the terrorist attack.

"Jesus!" Nick knew they were as safe as possible, given the circumstances, but that did not comfort him. When a limb—it might have been a Buggy's —bounced off the Tortoise's shell below the windshield, he clutched the tiller with a grip that death alone would slacken.

"They probably still want the Israelis out of Tehran."

"The Palestinians?"

"Whoever." Emily shrugged and pointed at the logo on the airliner's flank. "We should never have let Palestine Airways into the country. Once a terrorist, always a—"

"Look!" cried Andy. "Here come the cops!"

As the sound of sirens split the air, Nick peered upward through the windshield. Three Hawks hovered in the air above the expressway.

Chapter Two

The land spread out below, wheeling, turning, pivoting now on some skyscraper near the city's core, now on the crossing of two major roadways, now on the airport control tower. Small white clouds swung above. Broad, steel-grey wings swept through the peripheries of

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the pilot's vision, immense feathers twitching from time to time in response to the flow of air or to the muscles that controlled its path through the sky.

The pilot's name was Bernie, Bernie Fischer, and he was letting his Hawk soar at will while he bathed morosely in the whirling views. His hands rested lightly on the control yoke as he stared out over the sheet-metal cabinets, round-cornered, grey-enameled, of the vehicle's console. Behind one of the panels, he knew, was the computer that translated his manipulations of yoke, pedals, and knobs into landings, lift-offs, and smoothly sweeping turns to left and right.

His seat was enclosed by a broad bubble or pod of clear plastic, marked only by an oval door frame, and within that, a small porthole. The porthole seemed superfluous, unnecessary for vision when the door itself was transparent. It was there apparently because the door's manufacturer used the pattern for all its doors, clear or opaque.

The bird's serial number was painted on the fittings beneath Bernie's feet. To those fittings attached the heavy straps that held the pod to the Hawk's back. There was no need for structural metal or rotor-mountings, as in the helicopters that still were used at times.

Bernie was seeking comfort in the clean peace of the sky, reluctant to return to Earth, even though his shift was nearly over, even though he could go home to his small apartment and pour a drink or two and try to forget what he had seen this day. He wished he had someone waiting for him, someone he could talk to, someone whose touch could ease him when things went so badly awry in the world which he must deal with each day.

He had had chances, yes, he had. He had loved and been loved. He had come close to proposing. He had been proposed to. But he had held back, said no, temporized. He didn't dare, he told them all. It wouldn't be fair, for one day he might not come home.

Bernie Fischer was a cop. At times, he wished he wasn't, for only as a cop, or a physician or a paramedic, could he possibly encounter such horrors. Unless he or his should become a victim. He shuddered at the thought. Today's horror was too much for sanity.

His father had been a professional soldier. A peacetime soldier until the Venezuelan Crisis, when he and a thousand others had parachuted in to help a presidente and his cronies escape their thoroughly justified slaughter. He hadn't come back, and Bernie had seen the effects of the pain of his loss on his mother. She had lived only five years more.

There had been Bernie's own pain, too. He had learned to handle it, yes. He had survived. But every time he encountered atrocities like today's, he felt it anew.

Someone had enticed a young, black girl into a newly grown house in the suburb of Greenacres. There he had taped her mouth shut and put tourniquets on both her arms. He had removed the arms, just below the elbows, with an axe. He had raped her, fore and aft, with the amputated limbs. And finally, he had removed the tourniquets and left her to bleed to death. She had.

Bernie had heard of such things. There were people who were turned on

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by amputees. There were even people who were turned on by *being* amputees—to the extent that they would try to persuade surgeons to remove a leg, a foot, "At least a finger, please!" But this?

Her name had been Jasmine. Jasmine Willson. An old family name, her mother had said, again and again in those moments when she could talk half sensibly. Her grandmother's name, as Bernie's had been his grandfather's. She had been pretty, a good student, going steady, thinking of college. And some monster . . . Bernie couldn't help it. It was unprofessional, he knew. But the bastard *was* a monster. He was even worse of a monster because he had left no clues. No fingerprints. Not even any semen.

What other horrors were happening below him even now? He watched the concrete cityscape as it wheeled across his gaze. He stared at the greener suburbs, and the green, crisscross strips of the airport, with the big birds, big enough to dwarf his Hawk, landing and taking off in the distance.

His mouth began to water, his throat to tighten. He sniffed, suddenly aware of the rankness of his sweat. He needed, he thought, a shower. Then he opened the small port in the door beside him, knowing for the first time what it was there for, glad that it was there, leaned, and vomited into space.

The call came while he was rinsing his mouth from the thermos he always carried with him: "CODE NINER NINER. ALL OFFICERS TO REAGAN EXPRESSWAY, MILE THREE EIGHT. REPEAT: CODE NINER NINER. ALL OFFICERS TO REAGAN EXPRESSWAY, MILE THREE EIGHT, MILE THREE EIGHT."

Pausing only long enough to spit and close the port, he turned off the autopilot, seized the control yoke, and kicked the Hawk into a power dive toward Mile 38 on the old Reagan Expressway. Code 99 was a rare one. It meant a military or paramilitary attack. In this country, in this age of the world, it had to be terrorists.

His destination was not far away. As his Hawk cupped its wings to slow its dive, he saw two other Hawks arriving from nearer the city, diving like his own, converging on a scene of chaos. Traffic was backed up in both directions, six lanes of pavement covered with automobiles, Tortoises, Roachsters, Hoppers, and other Buggies. Only the zone immediately surrounding the Sparrow airliner was clear of vehicles, and the reason was obvious: the bare pavement was coated with blood and other body fluids and littered with the scraps of the Sparrow's meal.

Bernie was not surprised to see the logo on the Sparrow's side. The Palestinians—along with the Iranian Shi'ites, Lebanese Christians and Moslems, Irish Nationalists, and a hundred other factions—had long since broadened their battles to encompass all the world.

The three arriving Hawks began their siren calls together. The ululating rising-falling screams were as unlike a natural hawk's screech as they could be, for the gengineers had labored hard to mimic the sound of traditional police cars. They had succeeded, and now, as the three Hawks swept, screaming, into a tight circle above the carnage, the

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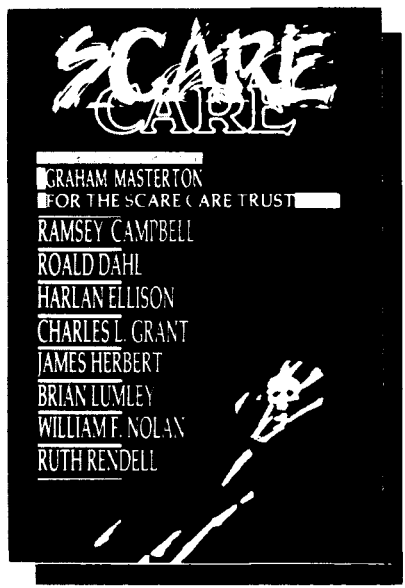

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Sparrow stopped its feeding and lowered itself on its legs. Then it cocked its head, half spread its wings and, beak agape, lunged at its threateners.

But the Hawks were still too high aloft. Bernie eyed his fellows. One—he recognized Connie Skoglund—held a microphone and was gesturing. When Bernie waved his acquiescence, the other's voice boomed out of the police radio: "YOU ARE UNDER ARREST! TAKE OFF IMMEDIATELY AND FOLLOW US. YOU ARE UNDER ARREST! COME QUIETLY, OR WE WILL BE FORCED TO STOOP!"

Bernie wished the rapist he had sought earlier was beneath him now. Hawks had replaced helicopters for most police purposes because their built-in weaponry, by its nature—beaks and talons as sharp as scythe blades, and larger—had more deterrent effect on evil-doers than machine guns or rockets. The Hawks were also quite effective at catching those who fled the scenes of their crimes.

The Sparrow—or its crew—ignored the threat. It sidled a few steps down the road, and its beak dipped once more into the grid-locked traffic. Years ago, Bernie reflected, that Sparrow and its crew and passengers would have been safe. Once terrorists had routinely taken hostages as guarantees of their own safety. But those days were gone. The world had learned, though sadly some terrorists continued to believe that publicity was enough of a reward.

The Hawks folded their wings and dived. The Sparrow sidestepped and its engines roared, their exhaust sweeping a number of Buggies across the pavement behind it, tumbling into each other and the ditch. To Bernie, one tiny detail stood out: a Roachster's antennae crumpling in the gust of hot exhaust; he could almost smell the scorching chitin.

The Sparrow spread its wings and lurched into the air. The Hawks lunged, trying to force it toward the airport.

It refused. Even though its stubby beak was no match for the predatory hooks and talons of the Hawks, it was larger. It slashed at its tormentors and, steadily gaining altitude, tried to push past their lunges.

The Hawks attacked. Their beaks slashed. Their talons seized and tore, and impacts jolted Bernie in his harness. The straps that held the Sparrow's engines and passenger pod in place gave way, and the Sparrow, too large to fly unaided, even without its burden of passengers, fell to the highway. Its engines also fell, smashing into the packed traffic. The passenger pod, when it too hit the pavement, broke open, spilling bodies amongst the wreckage already there.

The road was blocked as badly as ever, but now the end and a resumption of journeys was in sight. Long-legged police-model Roachsters and wrecker Crabs, waving massive claws above their cabs, were picking their ways down the embankments of the highway. Ambulances—gengineered from pigeons not only for the value of the symbolism, but also for their vertical-takeoff-and-landing abilities and for their broad, compact bodies that could support multigurney cargo pods—were descending on the road.

The Hawks perched on the Sparrow's carcass. The Hawks's red-brown tails

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jerked as they eyed their kill, and their hooked beaks opened and closed. Their talons dug possessively into the cooling flesh. Gouts of blood were visible as new spots on their plumage, especially against the dark-splashed cream of their undersides, the white of their throats and cheeks. They cocked their heads, each one marked as if it wore an ancient warrior's helm. A reddish crest, resembling a tonsure, suggested that those warriors might have been monks as well.

Bernie had never before seen a Hawk on the prey for which its ancestors had been named. Now he reflected that a Sparrowhawk, or Kestrel, had to be the perfect bird for police work. There were larger natural hawks, but that mattered little to gengineers who could resize a sparrow into a Sparrow. There was one Hawk, the Duck-Hawk, that had a single-barred helm and no tonsure, but it had been claimed by the Air Force. Other, less aptly marked raptors had gone to the other armed services—the Osprey to the Navy, the Broad-Winged Hawk, with its chevroned tail, to the Army, Harlan's Hawk to the Marines.

He knew that, if he left his Hawk to its own devices, it would feed. The instincts were there, after all; they were, in fact, a large part of what made a Hawk so effective for police work. But they had to be suppressed at times, especially when the public had already seen more than enough raw meat. He lifted a small, bright green hatch in the control panel to reveal a recessed toggle. The switch was wired to the Hawk's sleep center. When he flicked it, the bird would tuck its head beneath one wing and go dormant. It would wake only when he touched the switch again.

A puff of breeze ruffled the feathers at the crest of his Hawk's head. He flicked the switch. So did his fellow Hawkers, for even as his Hawk lifted one wing and bent its neck, so did theirs. In a moment, he joined his fellows on the ground. Connie was a thin brunette, as wiry and tough as the Hawk she flew; Bernie had dated her more than once, and he knew both the appeal of her soul and the strength of her body. The third Hawker was less familiar, though Bernie knew him—Larry Randecker, softer in appearance, almost chubby. Yet he was tough enough; Bernie thought his had been the Hawk that had sliced the Sparrow's engine straps. There had been no hesitation as Randecker had embraced the possibility that he would not be able to dodge the blades of incandescent gas erupting from the tumbling, still blasting jets.

The clean-up crews were already removing the wreckage from the roadway, loading the remains of vehicles into trailers and those of their drivers into body-bags and gurneys. The wreckers avoided the Sparrow and its pod, for they would have to be moved to the airport for examination. Proper emergency procedure allowed them only to open the liner's stomach to retrieve its victims. The genimal's body would have to wait for a Crane.

The medics working over the wreckage of the Sparrow's passenger pod kept the few survivors of the jet's fall separate, for they would have to be interrogated. The dead were trucked away to morgues, though first a single officer recorded their features with an elec-

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tronic camera. Later, he would record the living as well, and all would be checked against the police department's extensive files of known terrorists.

Bernie, Connie, and Larry were now traffic cops. They waded through the chaos of the scene, guiding vehicles that had, in their efforts to escape, gotten tangled in the ditches or on the embankments, or even in the roadway, back into position on the road. Using pocket recorders, they took names, addresses, and phone numbers of witnesses for later interviewing. And in due time, the road began to resemble nothing so much as a vast parking lot, covered with serried ranks of vehicles awaiting some signal to move.

One of the last vehicles that Bernie checked was a Tortoise in full withdrawal. In front, only its nose poked out of the crack between its shell and plastron. Its eyes were safely hidden away from pecking beaks; the headlights mounted on the lip of the shell served as giant surrogates. To the sides, only the stub-clawed toes showed. Inside the passenger compartment, a man, a woman, and a child, holding a bobtailed Cardinal feather, watched his approach. All were sweating heavily, although the vehicle's windows were open. He guessed they had waited to unseal the Tortoise until the Sparrow was dead.

He held their gaze with his own—the woman was attractive, but she was clearly unavailable, married—while he gestured for their attention. But then he let his eyes drop to the running board and the severed arm that lay upon it. It was a small arm, with a yellow plastic watchband around the wrist.

He bent, picked up the arm, and waved it overhead. From the corner of one eye, he noticed that the kid in the Tortoise's back seat stared, wide-eyed. His parents paled, and his father covered his mouth with one hand as if he too had a rebellious stomach.

In a moment, one of the medics, pale herself and shaking her head over the carnage, retrieved the arm. Only then did he turn on his recorder. "I'm collecting information on the witnesses," he said. "Your names?"

"Nick Gilman," said the driver. He pointed at the woman unnecessarily. "My wife, Emily."

"I'm Andy," said the kid. He waved his feather. "Boy, you really hit that Sparrow! Pow! It was eating everybody up!"

Bernie hoped Andy would never meet worse, as Jasmine had. The kid was too young to truly appreciate horror such as he had just witnessed, though it would surely sink in eventually. He might even have nightmares tonight, as Bernie expected for himself.

"Reason for being here?"

"I was picking Emily up at the airport."

"I was flying in from Washington. I work for Neoform."

He collected their home and work addresses and numbers before saying to the woman, "You're a gengineer, then?" When she nodded, he added, "Did you have anything to do with the Hawks?" Neoform, he knew, held the design patents.

"That was before my time," she said.

He snorted. "Whoever it was, tell 'em they're great. I love 'em." He

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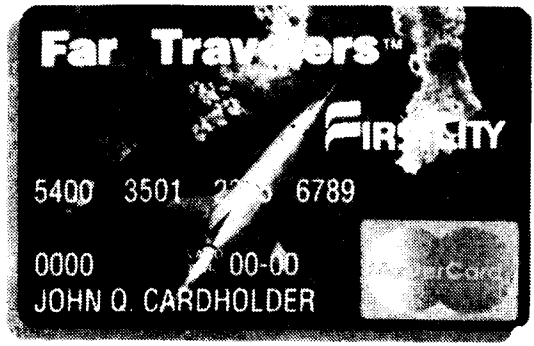
The Shape of Things to Come



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turned then to survey the road ahead of the Tortoise. A Starling short-hauler was unloading a crew of litterbugs to clean up the final, small scraps and the piles of dung left by both the Sparrow and its victims. "Shit-pickers" was what they really were, he thought, though most people preferred the less offensive label. Still, there was a strong tendency for people to call a spade a spade, almost despite themselves. "Litter" was now just another synonym for manure.

From the corner of his eye, he glimpsed an angular skeleton, like a tipsy rocket gantry against the sky, lurching toward them. It was the Crane from the airport's repair yard, all stiltlike legs and reaching neck, its beak fitted out with metal hooks and pulleys. It was already coming for the Sparrow's carcass.

There seemed to be a clear lane past the beak of the Sparrow. Connie and Larry were already guiding traffic in that direction. He pointed, "Through there. We'll be in touch for your statements."

Chapter Three

When the clock radio came on, Emily wanted to ignore it. Andy had awakened screaming at three in the morning, and now she felt distinctly shortchanged on sleep. But then the news began, and it was all a repeat of the nightmare of the day before. She growled softly and rolled out of bed. By the time she had turned the electronic voice off, she was awake.

She had not forgotten the carnage on the expressway, but every time she tried to think of it, or someone, or something—the radio—brought the subject up, her mind veered away to other thoughts. Right now, it reminded her that she and Nick had long ago decided that the best place for the radio was on a bureau several steps away from the bed. Mundane thoughts were a refuge to which she clung as if against her will.

She dressed. She watered the hanky bush on the bathroom window sill. She ate. By then Nick and Andy were up and bickering amicably over the profound question of whether doughnuts or toast would make a more satisfying breakfast. That settled, Andy went to the window to look at the bird feeder. "Mommy," he said. "See the Chickadee?" She did. "It was there yesterday." They watched it devouring the other, smaller birds. After a moment, he added wistfully, "Can you make it go away?"

"We'll call the airport later, kid," said Nick. "We'll tell them to come and get it."

"That's the only thing to do," said Emily. "We don't need that sort of reminder." Then she kissed both her men good-bye, broke a chunk from one of the doughnuts on the table, and left the house, first touching the garage door control by the front door. By the time she reached the garage, the Tortoise was already emerging. When it saw her, it cocked its head and lowered its shell for her just as it had for Nick and Andy the day before. When it saw the food in her hand, it also opened its cavernous mouth and uttered a soft "Whonk." She tossed the bite of cake between its jaws and patted its nose before she boarded.

She was painfully aware that the Tortoise was the family's only car, and that Nick often had shopping to do and errands to run. He could walk, but next

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year, when Andy entered school, might be another story. From time to time, Nick said something about looking for a job then, even going back to school if necessary.

So they would need a second vehicle. She wondered what it would be. A Beetle? A Roachster? Some other Buggy? Those had been awfully vulnerable on the expressway the day before. Another Tortoise? They had been safe, after all. How about something that could fly away from that sort of trouble. A Chickadee like the one on the lawn? But they needed airports.

Perhaps she could alter the design of the jellyfish-based Bioblimp she was working on. It didn't have to be the size of a moving van. If she could just halt its growth at some earlier stage, the result might be just right for a commuter. She would have to think about it.

Like the airport, Neoform Laboratories was surrounded by green. Trees shaded the parking lot, and white board fences marked off ample paddocks, as at a Kentucky horse farm. There was a track for testing the vehicular genimals. There were flower beds near every building, and the smell of flowers, and of hay, and of many kinds of litter.

Most of the outbuildings were red-painted, white-trimmed barns that housed the experimental stock and prototypes. One was an inflated fabric dome, its triangular panels alternating blue and gold. Jutting high above everything else and stabilized by guy wires, it had been erected for Emily's prototype Bioblimps. Later, she hoped, it would be the nursery for the first commercial models.

A concrete walk led from the parking lot to the entrance of the main building, a classic structure of contoured ledges and artful setbacks, all white concrete and tinted glass. The metal ductwork of the air-conditioning system prompted her to think of the future, when a bioform might replace the metal, pumping cooled air through the building with the bellows of its breath. Someday there might even be—but the Biological Revolution was still far too young for its future to be obvious. At a recent seminar, she had seen how flat surfaces — leaves or skins—could generate high-resolution images, their pixels nothing more than single cells that emitted bioluminescence, like fireflies or ocean algae or deep-sea fish, on command. Neural logics and signal processors were also under development.

The Neoform building was protected by the grey-haired receptionist who insisted on being called "Miss Carol." From her throne behind a low barricade just within the building's door, Miss Carol presided over four things: a small switchboard, a computer terminal, an electronic pad on which each person entering or leaving the premises was obliged to sign his or her name, and the control for the turnstile that blocked all passage. When she spoke, she displayed a deep southern accent.

Emily opened her thin briefcase for inspection, signed in, said she was glad to be back and yes-Miss-Carol she'd heard of the awful thing that had happened on the expressway and yes-Miss-Carol she expected that the memo on the meeting later on would be in her box. Finally, she squeezed through the turnstile and escaped. As soon as she

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was around the corner, she sighed with relief. When someone laughed, she started guiltily.

The odor of pipe tobacco told her who the laugher was before she turned. Frank Janifer, one of the company's few smokers, was standing in the doorway to the company library. "You didn't give her much of an opening, did you?"

Emily smiled. Frank was in marketing, and he knew everyone. "She'll go for half an hour."

"But only if you encourage her."

She snorted. "All you have to do is stand still! If you have any dirt to give her. . . ."

There was nothing slow about Frank. "So you were there?" He stepped into the hallway to walk beside her while she said as little as she could about the day before. As always, he made her feel small when he began to move. He wasn't tall, but he had the kind of bulk that came only with weight-lifting, and that was indeed Frank's hobby. He wore his blonde hair past his ears, and Emily had heard the single women in his department remark that it was a pity that he was gay. "Will you be giving us something to market soon?"

She shrugged. "We don't have a patent, if that's what you mean. But we do have a contract possibility." When he raised his eyebrows, she added, "It'll all come out at the meeting."

They parted at the door to her lab, where her technician, Alan Bryant, offered her the mug of coffee in his hand. "Thanks, Al." Her nostrils flared as she inhaled the welcome scent. "Anything new?"

He had a doctorate as good as hers, but he was younger, still new to the world of research. His position was the equivalent of the postdoc of the previous century. He took her briefcase and led the way toward her office cubby at the rear of the lab, in the corner by the window. "There's that meeting. . . ." They both ignored the computer workstation on the other side of the room. Its screen was running a simulation of the growth of a Bioblimp, from a hydrogen-filled egg floating in air to an adult blimp, its muscular tentacles unloading a ship.

She rummaged through the pile of mail that had accumulated in the past two days and found the memo. The first item on the agenda was her report on the patent hearing. Second was—

"And Chowdhury is pushing those armadilloes of his." Bryant's tone was not approving. The man he had mentioned was abrasive toward everyone, but he seemed to take a special pleasure in his sneers at blacks. Grudgingly, Bryant added, "He's got a prototype."

"He's wasting his time. General Bodies has that market locked up with their Roachsters." She paused, sipping at the coffee. Then she looked for her briefcase, found it on a chair, lifted it onto the desk, atop the litter of mail, and opened it. The paper she wanted was on top of the stack. "Do we have any kangaroo DNA on hand?"

Bryant shrugged. "I don't think so. But we can get it overnight."

She pointed at a computer-generated sketch. "While I was gone, I talked to a VP for Mayflower Van Lines. He was at the hearing. He liked the blimp's cargo handling and thought it could make a good moving van. But only if it had built-in cargo holds." The sketch

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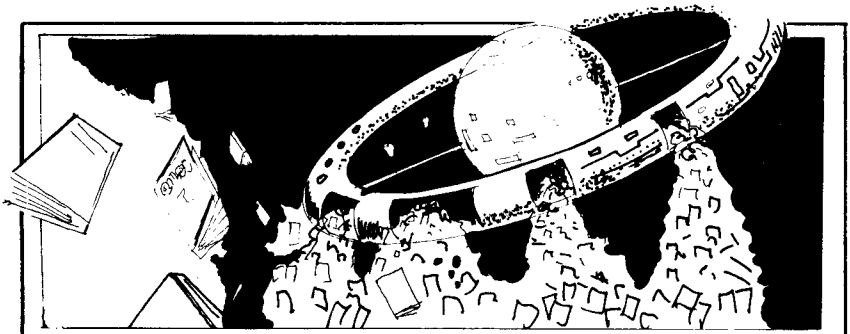

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showed a blimp hovering above a house. Tentacles were stuffing furniture into open-mouthed pouches on either side of the blimp.

"Gotcha." He turned and stepped to the computer workstation. A touch of his finger cancelled the growth-simulation program, and a genebank's long list of genetic stock began to scroll up the oversized screen. The genebanks were accustomed to hurry-up orders. "I'll get right on it."

The meeting was scheduled for ten. That gave Emily barely enough time to sort through the rest of her mail and pull her notes together. The company would want a formal, written report eventually. Right now, it wanted whatever she could give, in whatever form she could manage.

When she and Alan walked into the conference room, the research head, Sean Gelarean, was already there, marking the air with a touch of lime aftershave. Come to the States with the last gurgle of the British Brain Drain, he had found that his Mediterranean coloring could, for a change, make life easier. He told the story often: In England, he had been just another wog, his Palestinian ancestry weighing more than three generations of loyalty to the Crown. Here, he had blended in among hybridized Italians, Greeks, Spanish, Portuguese, Afghanis, Lebanese, and more. The old Italian-American family, the Campanas, into which he had in time married had barely noticed that he was not one of their particular group. Rumor had it that he had never converted to their Catholicism, that, in fact, he kept a prayer rug in his office closet and unrolled it five times a day to pray to Mecca in the east.

With the Campana money, he had become one of Neoform's founders. Not long after that, though still long before Emily's tenure with the company had begun, he had been the gengineer behind the Hawks that cop had appreciated so much. If further rumor were right, the fact that the Campana money had gone into making police vehicles might make him feel even better.

Also present were Frank Janifer and two aides from marketing, an anonymous VP from financial, and two of the firm's other gengineers, Ralph Chowdhury and Wilma Atkinson. A sharp edge of sweat overlaid the lime, Frank's tobacco, Wilma's floral perfume, and all the other less distinctive scents. Emily supposed the sweat belonged to Ralph, for that odor seemed to accompany him everywhere. He was dark of both hue and temperament, a half-Indian whose parents had escaped from South Africa after it went black. He wore flat-lensed spectacles that reflected the room's lights and hid his eyes.

Wilma was an asthenic blonde who specialized in decorative plant-animal hybrids. One of her products occupied a pot on a pedestal near the conference room's one window. Its form was as natural, yet as abstract, as branching coral; it swayed gracefully, and from time to time it emitted a soft, tuneful moan. Her work provided Neoform with one of its most successful and profitable product lines.

Everyone waited quietly while Emily straightened her notes to one side of the small keyboard and flat screen set flush

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in the table before her. She stalled a moment longer to plug her graphics disk into the drive slot next to the screen. When she was done at last, and her hands were folded atop her papers, Sean said, "I wish you had called last night, Emily. I wanted to know immediately."

Emily shrugged and opened her mouth. But before she could say anything, Frank interrupted: "I don't believe she was thinking of anything to do with work, Sean. She was on the expressway when—"

"Ah." The other nodded his greying head. The beginnings of the bulldog jowls he would wear not much later in his life wobbled. He hadn't known, he said, though he did not look surprised. He turned back to Emily. "But that's over and done with. You're safe, and we're glad of it." When the others had murmured their agreement, he added, "It would have been difficult, finding someone to take over your Bioblimp project." He sighed. "I probably would have had to do it myself."

Emily thought that he did not look displeased at the thought. She knew that he had accepted such chores in the past, and somehow, his name had always wound up the only one on the project.

"Do you feel up to giving us a report?" he said.

"Of course." She looked down at her papers, though she had little need to refresh her memory again. Then she told them what had gone on in Washington, adding some detail to what she had told her husband. The patent examiners had agreed that the Bioblimp indeed seemed original and patentable. But then had come the reason why the patent had not simply been issued, and a hearing had been called instead. A Pentagon general had appeared to claim that the Defense Department had already produced similar carriers for troops and cargo. To support the claim, he displayed a single sketch. Then he said that his office wished to classify both the patent application and Neoform's Bioblimp.

Wilma's artwork softly echoed her audience's groan. "Fortunately," she went on, "the hearing board shot that down. They pointed out that the application had already been published, and besides, the press was present. And then we—I and our lawyers—pointed out that according to the general's sketch. . . . " She paused to touch the keyboard, and a screen at the end of the room lit up with a lifelike diagram. "According to the general's sketch, the root stock was a very different species of cnidarian and the result lacked our cargo-handling tentacles. It had only a rudimentary fringe." A split-screen diagram emphasized the comparison. She shrugged as if to say that she had done her best. "The board took everything 'under advisement,' and we'll know their decision in a few days."

"Tell them about Mayflower," said Alan Bryant. Ralph Chowdhury scowled, as if offended by the temerity of a mere technician—or a black—who dared to speak, but he said nothing.

Emily looked at her boss, Sean, and activated her third computer graphic. "Alan is referring to a conversation I had with the vice-president for purchasing of Mayflower Van Lines. He was at the hearing, and he thought the Bioblimps, especially with their tentacles, might make good moving vans. *If* we can equip them with cargo holds. He

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didn't want strap-ons, he said, because the straps might break." Someone snorted. "I know," she added. "The airlines have no trouble. But we've already begun to look into marsupial genes." Frank muttered to one of his aides, who produced a disk, inserted it in the drive before her, and copied the graphic.

Sean held a single piece of paper in front of his bifocals. "I understand the Bioform Regulatory Administration posed an obstacle?"

"BRA just wants a more extensive environmental impact statement. But we can't prepare it until we know who our customers will be."

"Hah!" Chowdhury was scowling at her now. "You won't have any! Not if I know the military!" He didn't, Emily thought. But he had never let the truth keep him from attacking everyone within reach, as if he hated them all. His colleagues put up with him because they sympathized with his history, and because, for all his abrasiveness, he was a more than competent gengineer. He was, in fact, one of the best in the industry. Even Emily had to admit that he could do things with a genome that she could never attempt.

"If the decision goes against us," Emily replied, "I think we'll be able to get a military procurement contract. I have a feeling the general thought our design rather better than the one he had. The built-in cargo holds should only help."

Wilma changed the subject. "Have you heard the news, Emily?" When Emily shook her head, she went on, "They didn't find any terrorists at all on that Sparrow. It just stopped responding to its controls."

Frank began to look worried. "Do you think there's a defect in the gengineering? That could hurt sales."

"The station said the PLO, the Free Venezuelans, and the Boer Front have all called to claim the credit."

Frank laughed. So did Emily.

The research head rapped a pencil on the table. When he had their attention, he said, "I don't think that is our problem."

"But, Sean—"

"Wait until they say there's a defect. Or that the terrorists sabotaged the Sparrow in some way, which I think is more likely. Now we have a report from Dr. Chowdhury."

Chowdhury's motions, as he shoved a disk into his own drive slot with a loud click, were aggressive. He glared at everyone impartially, though his gaze seemed to avoid Sean and to linger just a little on Emily and Alan. "Such problems," he finally said, "certainly won't affect the Bioblimp. That is a dead-end. The true future of this company must lie with the armadillo-based vehicles I have been working on." He gestured, and the screen showed his own first diagram.

"The problem is the wheels," said Chowdhury. "When General Bodies designed their Roachster, they had an immense advantage. An arthropod's shell is laid down by an underlying membrane and is periodically replaced or molted. Once they had gengineered their hybrid to grow bumps in suitable places, beneath the legs. . . ." In most people's hands, such review was a comforting rite; in his, it grated.

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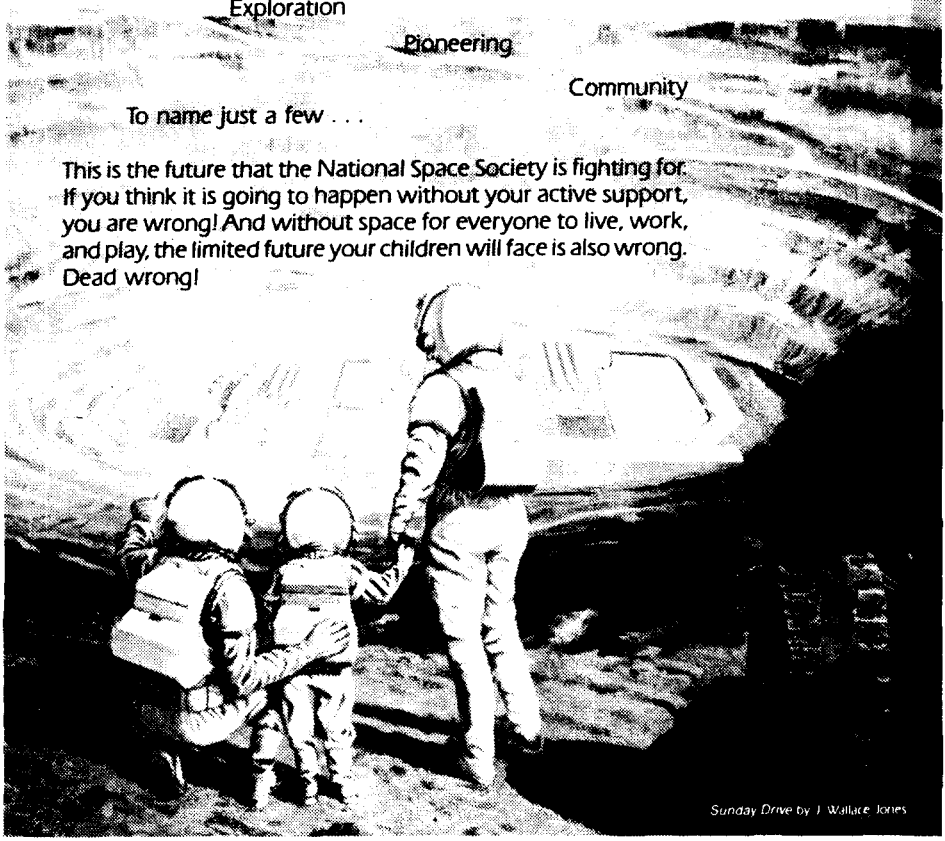

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He continued: "Then they could have the membrane secrete a second layer of shell inside those bumps, just within the first. It does this anyway at molting time. The difference comes in the shaping of the layers where the bumps neck down to join the body, so that the end result is a wheel mounted on a central hub. The genimal's legs run backwards on top of the wheels." Another diagram. "And when the wheel wears out, a molt replaces it.

"Unfortunately . . ." A photo replaced the computer graphic. It showed Chowdhury standing beside an armadillo whose back bulged well above his head. Emily thought that the world had seen nothing like it since the South American glyptodont had died out a millennia before, if then. The glyptodont had even had a tail, as did armadilloes. But the glyptodont's shell had not swelled out beneath its legs in four rounded bosses that looked exactly like the wheels of a Roachster. He went on, "An armadillo's shell is really a system of bony plates embedded in the skin. The plates are covered with horny scales, but the bone is what gives the shell its strength. That's a more internal tissue, and it is never molted. It was therefore difficult, but I did succeed in producing an armadillo with wheels. However, once those wheels wear out, replacing them is a much more time-consuming process. We may have to fit them with rubber tires."

"Why bother?" asked Frank. "With their Roachster, General Bodies has a lock on the wheeled genimal market."

"Sure," said Emily. "Why can't your 'Dillo Dillies' run on legs, like a Tortoise?"

Chowdhury, his voice taut with anger, said, "I prefer to call them. . . ." but the group's laughter drowned him out.

In a moment, when quiet reigned once more, Emily said, "But seriously, have you considered the main drawback to using armadilloes as your root stock?"

Chowdhury's voice grew tight, and Emily thought she could detect a change in the odor of his sweat. "There are no problems with my armadilloes!"

Emily showed her teeth in an apparent smile. It was hard to keep her mouth from shifting the little bit that would make the expression an unabashed snarl. "I've lived in Texas, Ralph, where the roads are splattered with dead armadilloes. The reason is simple: when they are startled, they leap straight upward, just to bumper height. It's a reflex; as such it's wired into their nervous systems, and into their genes, and it would be just wonderful for the reputation of your Dillies if the same reflex showed up under a highway overpass. Have you done anything about it?"

There was a moment's silence. Chowdhury scribbled quickly on one of the papers before him. Then he said smugly, "That is not necessary." He tapped his keyboard, and the room's screen wrote an equation beneath the photo. "Square-cube scaling turns the wild armadillo's leap into the merest of hops for my 'Armadons.' "

Frank raised a hand, one finger jutting toward the screen: "How can it even hop, with the legs on top of the wheels like that? Wouldn't it tear its wheels off?"

Alan laughed out loud. Emily was delighted. Chowdhury was far less so.

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His face darkened, and his fingers mashed his keyboard murderously. The screen blinked out. He said, "That is *not* a problem. I will be ready to demonstrate my prototype soon, and then you will see. I hope that you will even applaud."

No one had a chance to say anything more. A discreet beep sounded from their chief's, Sean Gelarean's, place. He leaned over his screen to read some message, and then he said, "Emily? Miss Carol says there's a police officer in the entry. She wants to interview you about the incident yesterday." He grinned, and the flesh around his eyes wrinkled. "She says she's disappointed that you didn't say anything this morning."

Emily snorted and rose from her seat. "I was in a rush." As she backed away from the table, she glimpsed Gelarean's feet—almost as small as her own—in the shadows beneath. He had kicked off one shoe so he could use the toes to scratch the other ankle.

Chapter Four

Bernie Fischer didn't own a genimal. He could afford one, and there were public stables where he could keep it. But he didn't need it, for his small apartment was not far from police headquarters, easily within range of the bicycle he rode today despite a grey sky and the promise of rain to combat the summer heat.

He craved peace, and quiet, and the soft, floating sensation of a Hawk on the wing. The bicycle, when the streets were smooth, as they were by spells, and the litterbugs had been doing their duty, as they generally had, came as close, he was sure, as he would get today. There would be paperwork on both the rape-mutilation and the expressway terrorist attack. There might be some legwork. He would probably not need the Hawk's speed or weaponry. They would, instead, delight some other member of the force.

He could at least look in on the Aerie before he had to face his desk. He grinned as he pedaled, dodging traffic and pedestrians. If, he told himself, he could get there early enough, he could spend a little time staring at the sleek forms of the Hawks. Perhaps, if the Aerie's grooms had not done their work as perfectly as usual, he could run a hand down a neck to straighten feathers.

But he never had the chance. As he pulled into the Aerie's yard, Connie Skoglund hailed him. She shouted, one arm upraised, her uniform blouse stretched tight across her torso, and once again he admired her. He changed course and stopped in front of her. Her scent, of soap and perfume, stood out against the earthier odors of the Aerie and made him think of other days, and nights.

"The Count wants you," she told him. "Right away." Above them, a Hawk noisily departed one of the Aerie's three launch platforms, small, circular decks set against the slanting roof. The platforms pivoted on central hubs, so that the blast shields erected along one edge would always be behind the Hawks when they took off into the wind. They reminded Bernie of the rotating gun platforms on naval warships in old movies.

He did not show his disappointment. The Hawks would have to wait, while

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he straightened feathers of another sort. "The Count" was Lieutenant Alexander, the chief of the department's detectives, and the nickname was appropriate. His parents, presumably suffering from pretensions to glory, had given him the first name of Napoleon.

"Any idea what for?"

Connie shrugged. "Something to do with that airliner. All I know is, I'm on witness duty. I've got about twenty of 'em to interview today."

"See you later?"

She looked at him appraisingly. "Dinner?" When he nodded, she added, "Come over to my place, then."

Historians know that Napoleon Bonaparte was short and suspect that Alexander the Great was not much taller. The Count did better on that score, for he and his immediate ancestors had enjoyed the benefits of better nutrition. His more distant ancestors had been of taller stock, and he was as blonde as only a Scandinavian, or one sprung from that region, can be.

He also had strikingly red lips. Though one might think that a Napoleon Alexander would be called "General" or "Emperor," and though he was fair, not dark, and was not given to long black capes, that feature was the one that had dictated the form of his nickname. If it failed to capture the flavor of his temper, no one seemed to mind.

"Fischer! How did those goddamn terrorists get away?"

Bernie, standing in front of his superior's desk, gave a deliberately sloppy imitation of a military salute. He had been in the army, and he wasn't about to give the SOB the real thing. "Sir?" The Count insisted on the word.

"The night shift checked the passengers. Three-quarters of them dead, and every one of them absolutely innocent. Passports in order, no guns in their briefcases or purses. Nothing!" The Count slapped a hand on his desktop in emphasis.

"The crew, sir?"

"Dead, every one of them. No one's talking. But their papers are in order, and . . . " He snarled. "They had to get away!"

"I didn't see anyone leave the Sparrow after it fell, sir."

The Count spun in his swivel chair to stare out his office window at the front of the Aerie. A rack of bicycles, including Bernie's, was visible in the yard below. He sighed gustily. Finally, he admitted, "We have the cockpit voice recorder. It actually looks like there *weren't* any terrorists. That Sparrow simply stopped responding to the controls. It just went berserk."

"Sir? But how? . . . " Bernie didn't own a genimal, but he knew they weren't supposed to act independently. They were supposed to be totally obedient to their masters, except when left to their own devices. That was the way the gengineers had designed them.

"I have no idea," muttered Lieutenant Alexander. More loudly, he added, "But they've got that thing in a hangar out at the airport, and they're taking it apart. If they find anything, they'll let us know. And then—even if they find litter!—you can get to work. I want the sonofabitch responsible!"

So did Bernie.

"While you're waiting on them, I

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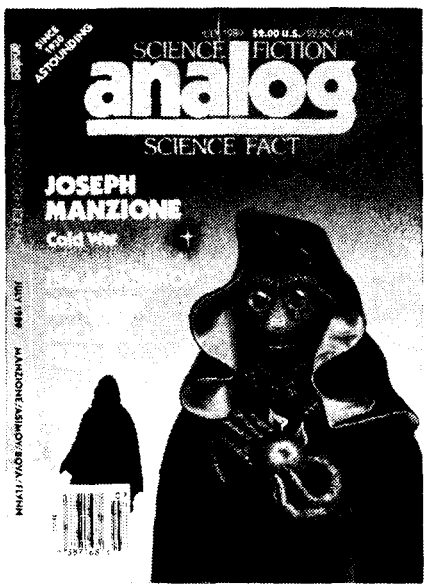

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want reports. On that rape thing, and on just what you did see yesterday."

Later that morning, after the overcast had burned off and the heat had returned, Bernie's phone rang, echoing around the carrel that served him as an office. He grinned as he lifted his hands from the keyboard of his official municipal antique, an electronic typewriter with a mere half-page of memory. Now, maybe, he could escape. Maybe he could get out of the building. Maybe he could even fly a—

It was the Count, and his message was simple: "They've found something out at the airport, and they want someone to come see. So go. And take a camera."

"Yes, sir!"

Delightedly, he launched the Hawk from the Aerie's uppermost platform, the jets thrusting the bird into the air, the wings snapping into place, the ground dropping abruptly away beneath him. He burned fuel with a prodigal hand, setting a direct course for the airport, wasting no time in soaring to gain altitude, certainly not to mesmerize himself with whirling landscapes as he had the day before.

Mere minutes later, he was descending on the hanger apron. Dust flew as he parked the Hawk, this time without the dormancy switch, for here there was nothing to make the bird misbehave. He dismounted, stroked his vehicle's neck feathers with one hand, and strode toward the small doof set like a sally port in the hangar's gate. The electronic camera he had brought bumped against his chest, swinging on the strap around his neck. It would record anything, in any light, that he could see with his eyes.

A balding man in a grey suit stood beside the door. Bernie introduced himself and held out a hand. The other took it, said, "Alan Praeger, Air Board," and opened the door. As it closed behind them, Bernie stopped, frozen in place by the scene before him.

The hangar was, of course, large enough for an airliner. A distant air-compressor labored inadequately to fight off the Sun that beat down on the metal roof; the cavernous room stank of sweat and dust and spoiling meat. The Sparrow sprawled across the concrete floor and was dwarfed by the walls around it, and by the human mind's insistence on interpreting walls on a more human scale. Yet it was recognizably a sparrow, a small—tiny—bird, and it paradoxically shrank the hangar to the point that the white-coated technicians laboring over the spotlit chest, neck, and head seemed to have escaped from some tale of munchkins or brownies.

The Sparrow's abdomen was open, the exposed flesh already dark and dry; that was, Bernie thought, where the rescue crews had cut to retrieve the bird's victims. Great gashes, still shining wet, had clearly only recently been opened by the technicians' laser scalpels. "We've been dissecting the thing," said Praeger with a gesture.

"I hear you found something?"

"Over there." Praeger pointed to the other side of the hangar's cavernous space, where more spotlights illuminated the Sparrow's passenger pod. More technicians labored there, their efforts concentrated on the cockpit area.

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Praeger started walking, and Bernie followed.

A bench had been set up to one side of the work area. Most of it was covered with the workers' tools and test instruments. One end was clear, except for a padded case that stood open like a casket awaiting a shipment of crown jewels. Their course, Bernie realized, would end at that casket, and he wondered what they had found.

Praeger pointed at the casket. The padding was creased in the center, like that in a jeweler's ring box. In the crease rested a black plastic oblong with numerous metallic legs. "A chip," said Bernie.

Praeger nodded. "It had been added to the controller's motherboard. We have no idea what it does yet." He drew a pen from his shirt pocket and pointed at a line of identifying numbers on the chip's casing. "We do know it's a PROM—programmable read-only memory—chip. With the right equipment, someone could have stored a program in this thing."

And if that program could have taken over the Sparrow. . . . "The perfect sabotage," said Bernie. "Like a virus program." The police had been dealing with those for decades.

Praeger nodded again. "Long-distance. Remote control. And untraceable."

Bernie could already visualize other possibilities. A crook could make an armored car deliver its cargo wherever he wished. Or send a murder victim's vehicle over a cliff. Or separate a kidnap target from its guards. Or . . . He reached for the casket.

Praeger stopped him. "No, officer. This is a federal case." Bernie agreed reluctantly. The man was right on two counts: Anything to do with terrorism was inevitably and promptly yanked out of local hands, as was anything that interfered with interstate commerce. But the feds did know that the local yokels could help. That was why they had summoned him, and— "It stays with us. We'll let you know when we've analyzed the program."

Bernie had to settle for what his camera could record.

Aloft once more, Bernie set his Hawk to soaring in circles, but this time he paid little attention to the whirling landscape. He was thinking: It would be weeks before the feds had any results to share, and there was no reason to expect that the chip would reveal a thing about who had set it to subvert the Sparrow. He needed a different approach, an alternative way to seek the villain responsible.

Could he dismiss the idea that terrorists had done the deed? Too many groups had tried to claim the credit, but he could not rule out the possibility. He preferred it, in fact, to the thought that the villain was some nut bent on random destruction. Either might be the case, though he would rather hunt a rational foe—if rational was a word that could possibly fit such a crime—one with a reason for his act, for through that reason, he might be able to track the man.

Bernie reflected on what any detective had to look for when he sought to solve a mystery. *Modus operandi?* That was unique, and therefore no help. There would be no clues in the department's records of the past. Did anyone

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gain from the Sparrow's attack? There must be dozens of insurance beneficiaries, heirs, disgruntled spouses. The sort of pedestrian gruntwork needed to check all of them out could safely be called a last resort. Who had had the opportunity to install the chip? Just every maintenance worker and pilot who had ever been in the Sparrow's cockpit, in every airport it had ever landed in. Even, for that matter, in the factory that had built and installed the control unit.

What was left? Nothing. It was indeed the perfect crime, untrackable until the villain—terrorist or whatever—said or did something to rouse suspicion. Perhaps, however, he could study that *modus operandi*. He could find out, even before the feds reported, just how a nonspec chip like the one they had found would have to work. How could a tiny thing like that possibly take over something as huge as an airliner? How could it possibly make the airliner do things so far outside its normal range of behaviors?

He needed a gengineer. Fortunately, he remembered, he knew one. He had met her just the day before. She had even been on the expressway, in the midst of the disaster, and she should therefore have some interest in the case. Now all he had to do was remember her name, and where she worked. Unfortunately, all the papers he had filled out, with all the information he needed, were back in the office.

But . . . Neoform was the company. That much he recalled. And he knew where that was located. He tipped the Hawk's soaring from its endless circles into a straight-line course. As he flew, he struggled to recall the name. The kid, the kid with the feather, his name had been Andy. Hers? . . . The Neoform complex grew visible in the distance, and it came to him: Emily.

When he reached the Neoform headquarters, he was surprised to find another departmental Hawk in the parking lot. It had been toggled into dormancy, presumably because of the Buggies that surrounded it. If it had not been shut down, it might not have been able to resist temptation.

He took an empty space across the aisle, positioning his Hawk so that it faced the other, and put it to sleep as well. Who else was here? Was their business related at all to his own? He supposed he would find out soon enough.

As he walked toward the building entrance, he noticed a Tortoise drinking from the trough before it. Its shell bore splatters of something that had once been liquid. He supposed that most who noticed would have no idea of what the liquid might have been. To him, the splatters said that this was indeed the right place, and Emily—Emily Gilman, that was it—was here.

As he approached the glass doorway, he thought he recognized the figure standing before the receptionist's barrier. Connie, here? She had said she would be interviewing witnesses, and the computer would have parcelled out the lists. Had it been alphabetic? Or random? His hand hovered over the door handle, and he decided it didn't matter. It was just coincidence that their paths had crossed here and now.

When he entered, the receptionist's eyebrows rose dramatically, as if to say

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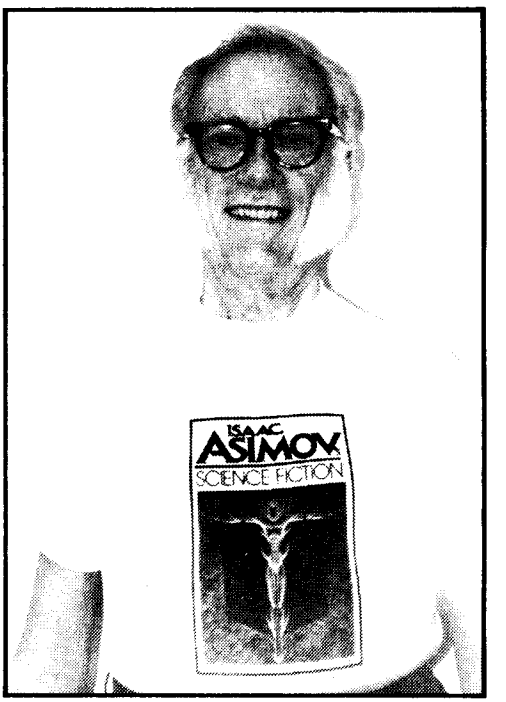

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that one cop on the premises was unusual enough, but two? He ignored her. "Hi, Connie. Mrs. Gilman?"

"She was in a meeting. She's on the way down now."

She had hardly finished speaking when a slim, dark-haired woman rounded the corner. Her dress was tailored both for an appearance of professional competence and for utility—one breast pocket, loaded with pens, had obviously been stiffened to resist sagging; two side pockets, just forward of her hips, supported folded papers.

As Emily approached, her gaze swung back and forth between them. "Yes?"

Connie spoke first: "Dr. Gilman? We're interviewing as many witnesses to yesterday's incident as we can."

"An incident, is it now?" She looked at Bernie, and her eyes widened with recognition. "You're the one who . . . "

"I'm investigating the Sparrow from another angle," he said. "I need some background on how genimals are controlled, and I thought of you."

She smiled at him. "I'll be delighted to help. But I'm afraid I can only oblige one of you today. I've been out of town. . . . "

"You were here first, Connie." He turned back to Emily. "Tomorrow?"

They made the appointment. When they had shaken hands, he gave Connie a mock salute and left.

Connie's apartment was warm with polished wood, fabrics whose roughness was meant to suggest handweaving, and soft cushions. The floors wore braided rugs. The walls bore art photos printed in metallic inks on glass.

Bernie lay supine on her bed. She sat erect beside him. One of his hands lay on her thigh. One of hers was flat on his bare chest. He circled his index finger in the sweat on her skin. She pretended to coil the same finger in the scant hair between his nipples. He let his eyes wander over her: so slender that she might have seemed anorexic if her muscles weren't so clearly, cleanly drawn beneath the skin, small breasts like plums—hard and sweet—corded neck, fine-drawn features. She surveyed him as well: as strong as she in the male way that needs less work to maintain the muscles, the early signs of later paunch—she pinched his belly flesh — square hands, blocky features, rugged.

If he had gone home when he got off work, he would have fried a couple of hot dogs, or a pork chop, and opened a beer. Connie had stuck lasagna from the freezer in her microwave and opened a bottle of wine. Then she had actually made a salad, and he got a dose of the greens his mother had always told him never to forget to eat.

He closed his eyes while Connie fingered his chest hair. He squeezed her thigh, and he thought that she was good for him. Just what he needed. Maybe . . .

"Hey, Bernie." She tweaked a hair. "Think you'll ever get close to her?" She reached downward with her other hand. "Close like this?"

"Huh? Who you talkin' about?" He opened his eyes. She was smiling.

"Mrs. Gilman. That good-lookin' Emily. She was lookin' at you, Bernie."

"Aaahh, you're full of it, Skoglund." She had looked at him, there in the Neoform entrance lobby, just as she had

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looked at Connie, just as she would look at any vaguely familiar stranger. There had been no sign of any deeper interest, and he thought that surely he would have known.

"No, I mean it. I think you turn her on."

He felt himself turning red.

"Oh, my," she said. "I never knew a man could blush like that!" She laughed. Her hand left his chest and touched the side of his face. "From here . . . " It slid down his neck, over his shoulder, and back to his chest. "To here."

"Come on, Connie!" His voice plaintive, he tried to sit up.

She pushed him back. "Uh, uh. Don't run away. I've always known you were sensitive, Bernie. It's why I like you. Why you're here now."

He glared up at her. "So why push my buttons?"

She giggled. "There's only one button I want to push. The same one she does, I bet. Think it'll work again?"

There was a pause, another giggle, a rustling of sheets as they changed their positions. Then, "Go for it, fella."

Chapter Five

Ralph Chowdhury's lab might have seemed strange to another scientist, even to another gengineer. The computer workstations, screens aglow with graphic simulations and columns of figures, were normal enough. So were the scattered aquaria, shelves of reagents, enameled freezers, stainless steel incubators, and LED-illuminated DNA splicers. But Chowdhury's desk, carefully centered before the greenboard at the head of the room, looked much more like a schoolmaster's podium than like a researcher's workspace. The desk was a high, slant-topped affair at which he sat on a high stool, his feet wrapped around the rungs. The other desks and work benches in his lab were less extreme in their idiosyncracy, but they too were higher than normal, and Chowdhury expected his aides to use the stools he had provided for them.

It might have seemed stranger to visitors from Neoform's financial or marketing departments. They, too, favored more conventional furniture, but they would have found most alarming precisely what no gengineer would blink at: the strange things floating in the aquaria, the *particular* subjects of the graphic simulations, the dried puffer hanging above Adam Chand's workstation. They promised new products for the company, but they also gave Chowdhury's lab something of the air of an alchemist's workshop. There was missing only a suitable array of alembics and a grimoire or two, though that absence had never struck Chowdhury. His lab was as it was because, quite simply, he had once seen an old photo of a Bombay accounting shop, with rows of bookkeepers perched on stools and leaning over heavy ledgers set on slant-topped lecterns. He knew perfectly well that modern Indians, like accountants and bookkeepers through the world, now used desktop computers, but he had inescapably identified that photo with his ethnic heritage. And as soon as he had earned the right to dictate the design of his own lab, he had exercised that right.

Adam Chand was one of Chowdhury's three technicians. He had found

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the puffer in an antique shop the summer before, its bleached and empty body inflated like a balloon, but stiff, all spines and prickles. The storekeeper had told him that they were also called blowfish, that they inflated themselves with air to foil predators. At times they had been used as lanterns, housing candles, and that in Japan, as *fugu,* they were considered delicacies, but only if the chef was successful in removing the toxic inner organs.

Now, beneath the puffer's dry benison, Chand labored, exploring the puffer's genome. He had long since, in his spare moments, confirmed the dealer's tales through the data bases. Then he had wondered if the fish could be enlarged and its air cavity turned into a compartment for passengers, cargo, and engines. Gengineers had tried, he knew, to turn porpoises and whales into bioform submarines, but so far they had failed. If he could be the first to succeed. . . . Once, he had admitted to his boss that at night he dreamed of a promotion to a lab of his own. Chowdhury presumed he still did, though he no longer dared to speak of it.

Chowdhury's other two technicians were busy, too. Micaela Potonegra, at another terminal, was working on production schedules for the Armadons. Zhang Dong—everyone but Chowdhury called him Sam—was using the DNA splicer to make certain changes Chowdhury had ordered in several genes taken from a coral snake. Chowdhury, not having told him what genes he was working on, had watched expressionlessly as Dong had consulted the genebanks and learned that they controlled venom production. He had not tried to learn what effects his changes would have.

The door to the lab slammed. Chowdhury had returned from the meeting at which Emily Gilman had presented the results of her Washington trip and then had ridiculed his Armadons. His technicians stared at him. He stared back. His mouth was a line, his eyes hidden behind his spectacles, his arms stiff at his sides. Chand was the only one who dared to speak: "Dr. Chowdhury? There's an interesting gene complex in these puffers. . . . "

He turned toward Chand. He spoke quietly: "Those verdant puffers are none of our business, *Dr.* Chand. Work on them on your own time. And now . . . " Suddenly, he screamed, "Out!"

The three were used to being banished. Without a word, Chand and Potonegra closed down their terminals. Dong touched a button, and the splicer spat out a cassette containing the material he had been working on and the reagents he had been using: he would take it to the alternate lab they had set up in the prototype barn. There they could continue their work.

The barn was isolated from Neoform's main building and other workers, and it could be noisy, for many genimals, like their unmodified ancestors, had voices, and used them. Yet, in some ways, the technicians preferred the place. Despite the noise, and sometimes the stink, it was peaceful. It was also comfortable, for the barn lab's desks and benches were all of standard height, unlike the furniture Chowdhury preferred, and the seats were padded swivel chairs.

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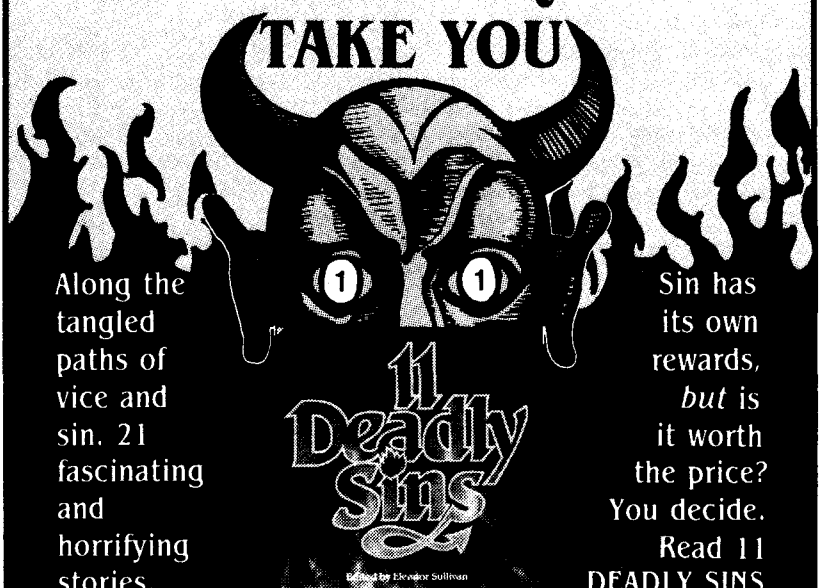

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Now Chowdhury hunched on his high stool, facing his high podium, and stared at nothing. His phone occupied a shelf beneath his desktop. His computer terminal rested on a table, flat-topped but of a height to match his desk, to his right. To his left, another table bore a salt-water aquarium.

"Dillo Dillies!" His head twitched, and a vagrant sunbeam glanced off the flat planes of his spectacles to put a cursor on the wall. His Armadons would outdo those Roachsters! He knew it! The company was wasting its money on Emily Gilman's Bioblimps. He turned to stare at his aquarium. It had been handy having a source of jellyfish on the premises. But there was no need for new cargo vehicles, and no money in them.

They refused to see the truth. They even ridiculed him. And now the police were here. Here!

His phone rang. He picked it up, listened, and was glad that he had thrown his technicians out. He could feel the beads of sweat upon his brow, knew that he was cringing, shrinking upon his stool.

He said: "I know what I owe them. I know what I promised. And part of the package is ready now. The rest is almost ready." There was a pause while he listened. Then he hung up and dropped his forehead into his hands, his fingers gripping his scalp. Years before, he had taken a vacation in Las Vegas. He had gambled. He had won. And when he had come home, there had been an invitation to a local club, a back room in a restaurant in an ordinary middle-class neighborhood. He had gambled again. And he had lost. They had offered him credit. And he had lost that.

And then . . .

He was perversely glad that the phone call had come from that particular caller. He knew the man, and though he had asked Chowdhury to do things of which he had never dreamed, and though he had uttered words that promised that Chowdhury would do far more hateful deeds, deeds he could never conceive of dreaming. . . . He sighed. It would be still worse to be owned by some outsider.

He knew why he had fallen into the trap. He had been born in this country. But his parents had been South African "coloreds." His father had been a hybrid of Boer and African, his mother a sari-wearing descendant of Indian merchants. Both had been physicians, and well off compared to other members of their underclass. But they *had* belonged to an underclass, and he had been weaned on the bitter tales of how neither had ever been allowed into such precincts of privilege and wealth as the local casinos. He had seized his opportunity with the eagerness of the culturally deprived.

And then— The man before him had had the well-fed beefiness of the Boers who had tyrannized his parents. He sat at a broad desk, polished until his inverted reflection doubled the stares aimed Chowdhury's way. One hand rested on a stack of yellow slips, the credit markers that measured Chowdhury's foolishness. The other held a small glass vial. A pair of bodyguards flanked the door behind Chowdhury. A safe stood open in the paneled wall to the left.

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"We have let you get much too far into us, Dr. Chowdhury."

He stared at the large diamond that held the other's black tie flat against his shirt front.

"You don't seem to have wondered why." A sigh. "They never do. But now it's time to pay."

"I can't."

"You can. You even have a choice of methods." The other held up the vial and shook it to make the tiny capsule within it rattle. The glass sparkled in the light. "One way is to take this pill."

Chowdhury shrank within. He had heard. He knew. The Biological Revolution had put an end to drug smuggling, but not to addiction. Someone, early on, had fitted tapeworms and other parasites with the genes for heroin, cannabinol, cocaine, mescaline, and other substances. There were even parasites for alcoholics. The parasites' eggs could be washed from an addict's wastes and given to anyone who wished infection; some addicts carried a dozen different parasites, and their brains were a chemical stew unmatched since the drug-happy days of the 1960s.

For the first time in history, addicts never had to come down, or worry about how to pay for their next hit. Overdoses were inevitable, for as the parasites grew, they secreted more and more of their drugs, but the addicts never thought of the death awaiting them.

Nor did they think of how their convenience had hurt the drug trade. The man before Chowdhury had. "Take this," he said. "And you will be a very happy man."

It would cost him his job, his career, his very wish to do the gengineering he loved. "And a dead one," whispered Chowdhury. He could not take his eyes off the vial.

The other shrugged. "Eventually. Or . . . "

Did Chowdhury sense a possible reprieve? He looked up, from the vial to the diamond again, to the soft chin, the unblinking eyes.

Another sigh. "These hedonic parasites cost us a very profitable line of business. But they do have a drawback—once one is infected, one is never again free of the drug, even if one should wish to be so. We have wondered whether it would be possible to gengineer an animal, or a plant, that would administer a drug only on command?"

"A snake? A nettle?"

The other's smile showed teeth but did not touch his eyes. "Ah, you understand. And as soon as you bring us something along those lines, something *marketable* you understand, we'll tear these up." He held the credit markers up. One of the bodyguards stepped past Chowdhury to take them, and the vial, and return them to the safe.

"Shall we say—cocaine? Until then, I'm afraid, we can't allow you to gamble any more of our money."

The cocaine nettle had been easy. Nettle leaves and stalks are covered with tiny, sharp-tipped, hollow hairs. Normally the hairs are filled with venom; when a person brushes against the plant, the hair tips break off and the hairs inject their venom into the skin; the result is an intense itching, burning sensation. All he had had to do was change the

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venom genes so that the hairs were filled with a strong cocaine solution.

He had known what he was doing. He had done it anyway, telling himself that it was inevitable. New technology first went to major uses, such as Roachsters, Sparrows, and Armadons, even Bioblimps. Soon thereafter, even before it spread widely in legitimate industry, it began to affect crime, and the underworld use of the technology might even find its way to influencing the legitimate.

He had delivered the cocaine nettle within a month, and he had done so proudly, if warily. Now its scions grew in pots all across the country, while those with the money to buy them, and their guests . . .

The head of Neoform's legal department had thrown a party for the company's upper-level staff. He had gone, and in the man's apartment he had seen his creation. A large nettle sat atop the baby grand piano, a second as a centerpiece amid the buffet, a third on the wet bar. The man had called it something new, something expensive, something marvelous, Neoform should have come up with it, see, just pet it, and feel great!

Someone had tried it, and then another. Someone else had said, "That feels like cocaine!" and tried to explain how millions once had snorted white powder through narrow tubes, rolled dollar bills, rolled . . . Governments had been powerless as drug money fueled a criminal empire that stretched from South America around the world. But then the parasites had killed almost all the market. There were very few left who preferred their coke the old-fashioned way. Fortunately, she had once dated one of them.

"Let's try a leaf!" She had plucked one, rolled it, inserted it into her nose, and gasped. It had not been long before the lawyer's three plants were reduced to stumps. Chowdhury had had to reassure him that they would quickly regrow from their roots, though he had not confessed his role in the plant's creation.

But his markers had not been destroyed. Someone else had called. A new master who would hold them as a club, while doling out money enough to buy a new Roachster, and talk of fame and wealth, if only he would produce a hedonic pet or two. They wanted genimals, this time. Something cute, perhaps. Something that only he, gengineer par excellence, could possibly create.

He looked at his aquarium again. In it floated a small jellyfish. If it were wild, its tentacles would be studded with cnidoblasts. Some cnidoblasts, when touched, would expel minute threads to entangle prey. Others would expel sticky tubes. Still others would discharge barbed needles loaded with paralyzing toxin. His jellyfish had only the third type of cnidoblast. Its needles he had smoothed of barbs and filled with heroin. If he petted it . . .

He didn't think his masters from the underworld—did anyone still call it the Mafia? the Cosa Nostra?—would like the jellyfish. He would show it to them, but he expected they would prefer his tiny asp, its venom sacs loaded with drugs, the snake just of a size to coil around a lady's throat and, on command, bite her pretty earlobe. Soon he

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would have a rattlesnake, a coral snake, a mamba. Drugs to be worn. Drugs as fashion. Perhaps he would try a bee, or a spider.

If only his masters were Indian, or half-Indian, like himself. Whites reminded him of the verdant Boers, while blacks . . .

Ah! The stories he had grown up on! His parents, young then, shoulder to shoulder with all the oppressed blacks and coloreds, resisting the Boers, giving *them* the Cape Town necklaces of flaming rubber tires, expelling them, those that survived, from the country. And then, with help from America, Europe, Russia, China, everywhere, rebuilding the nation's shattered economy.

His parents had not been there to see success. Through all of Africa, the merchants derived from India, China, and Southeast Asia were hated only a little less than the whites. And with the whites gone, the blacks had turned on their allies. The Chowdhurys had been among the few to escape the pogroms.

He had chosen his technicians carefully. None were white. None were Kaffirs, schwartzers. One, Chand, was of Indian ancestry. Potonegra was from Guatemala. Dong was Chinese. They were safe. He could work with them, unlike Emily Gilman, or her technician, Alan Bryant, the black.

He activated his computer terminal. He called up the appropriate data base, and he found that Emily had been quite right. Armadilloes did indeed jump straight upward when startled, and on highways that reflex did indeed lead to many deaths.

He had his own copy of the armadillo genome, with every gene labelled. He called it up, found the genes that specified the neural circuits behind the reflex. Then he checked the Armadon genome. He shook his head when he found the same genes there. It must have the same circuitry, the same reflex. A quick simulation confirmed that an Armadon did not have the strength to jump, but, yes, it could tear its own wheels off. Just what the customer would want in an emergency. He chuckled.

With the simulator, he explored the effects of modifying or deleting various genes and bits of circuitry. One change left the Armadon unable to move its legs at all. Another limited its speed. Still another . . . Finally, he found the change that removed only the startle reflex. He would have Micaela implement it immediately. Then they could grow another prototype, and he would have his fame and fortune without the underworld.

Chapter Six

Some things never change. Emily Gilman's grandmother would have been bewildered by what now passed for airplanes and automobiles. But she would have felt quite at home in her granddaughter's kitchen. The appliances were all quite recognizable, for the only changes that had come over the decades were in size and shape and placement of the knobs.

That wasn't fair, thought Emily. There were other changes as well. For one thing, it had been her grandmother who ruled her kitchen. Here and now, it was Nick, and this kitchen was far more his than hers. Almost the only thing she did in there was make bread.

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And she didn't do that often enough, for it was less a way to feed her family than to sublimate aggression and work off frustration.

Her grandmother would have thought the arrangement strange, even though in her time househusbands were not all that uncommon. Perhaps it was. Emily felt at times that their roles were too far reversed. She should be the nurturer, he the breadwinner. When they had met, in college, they had both been sure that that would be their pattern, as soon as his poems, perhaps as songs, or his fiction—would he wind up writing for the veedo?—made him rich and famous. It hadn't worked out that way.

And how about the computerized voice synthesizer in the toaster oven? She had sliced a bagel, laid it on the rack, and set the knobs for "Dark." Now it chimed gently and announced in a warmly maternal tone, "I'm getting close." In a moment, it would say, "I'm ready! Aren't you? I'll keep it warm." If she did not respond, it would do just that, automatically adjusting its temperature to keep the bagel from burning.

Too many of them talked like that. And it could drive you nuts. Of course, the voices could be turned off, but when you had a small child around the house, you let the gadgets talk. He loved it so. And it could save a parent so much nagging, as when the toilet said, "Don't forget to wash your hands."

The bagel turned brown behind the toaster's tiny, oblong window. The appliance spoke its piece, she pressed the latch bar, and it delivered up her breakfast. She spread cream cheese, poured coffee, and began to eat.

Moments later, Andy ran into the kitchen, still in his pajamas, eyes still gummed with sleep, breath smelling of toothpaste, and yelled, "Mommy!" She hugged him with the arm whose hand did not hold half a bagel and offered him a bite.

Nick appeared, hair uncombed, and said, "C'mon, kiddo. You've brushed, but you haven't washed."

"Unh-unhhh!" Andy twisted away from his mother and threw himself across the room into the chair by the window. He knelt there and peered toward the bird feeder, his nose reinforcing the smudge on the glass. Emily took another bite of her bagel. Nick stepped toward their son, his hand outstretched.

Andy pointed. "Look at that, Daddy! That's a funny one!"

Nick bent until his head was beside his son's and he, too, could see out the window. "You're right," he said. Emily could see his attention withdraw from all thought of getting the boy washed up. "I've never seen one like that before. Look, dear."

Emily didn't want to look at any goddamn birds. She had seen enough of them lately. She checked the gold-framed digital on her wrist. "I'm running late. Gotta rush." She sipped her coffee, but then she discovered it was still too hot to drink rapidly.

"Stop and smell the flowers, sweetheart. It's got long legs and a beak like a dagger. Like a small heron or egret. But grey with orange streaks." She winced and thought that, yes, he did know how to pause and appreciate the small accidents of life: flowers by the wayside, birds upon the lawn. Once she

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had been able to do the same. "Where's the Peterson?" he asked.

He found the bird guide on top of the refrigerator and flipped through the plates. He hesitated, flipped again, turned back, and held the page for her to see. "It's not here," he said. "But it looks kind of like a bittern." The picture by his finger was of a drab brown bird, beady eyes framing a beak held straight upward to aid its camouflage among the reeds of a swamp.

What, she wondered, would a bittern be doing in a suburban backyard? Surely, every swamp in the county had been drained and filled a century ago, or more. Was there some sort of race memory that sent bitterns back to the swamps of their ancestors? Had there once been a swamp beneath their yard? Or was it not really a bittern?

A shadow wheeled across the window, and both the room and the yard outside darkened momentarily. "The Chickadee's back!" cried Andy's delighted voice.

Nick turned back to the window. "Hey! It's grabbin' for it, Emily! The stranger's dodgin', flappin' its wings, trying to take off!"

"It made it!" Andy crowed. He had a Warbird in his hand, red plastic in the shape of an Eagle bearing a pod bedecked with futuristic weaponry. Now he waved the toy in the air and shrilled a war cry.

"Please!" Finally Emily set down her cup and crossed to the window to see what all the fuss was about. The strange bird was no longer in sight, though a few brown and orange feathers were just sashaying down through the air, settling to the ground. The Chickadee was staring into the sky, cocking its black-capped head toward the house, peering toward the nearest tree, and spinning with amazing lightness to seize a robin that only wanted to find a worm for its own breakfast.

Emily felt her gorge beginning to rise. The incident on the expressway had been more than enough to wipe from her mind any tendency she had ever had to find overgrown, jet-assisted carnivores charming, with or without their jets. She swallowed convulsively and sipped coffee to clear the taste from her mouth. Then she tipped her mug to the ceiling and finished the last of it. "I thought you were going to call the airport?"

Nick shrugged. "I did. And they came and got it."

She glared at him. "Obviously, it got loose again."

"You're not going to call them again, are you, Daddy?"

Emily put just a hint of steel in her voice. "You'd better."

Her husband waved one hand toward the ceiling, palm upward, fingers spread as if he were throwing a handful of bird seed into the air. He made a face that suggested, she supposed, resigned confusion. "But why bother? Andy loves it."

"Yeah!"

She nodded. "I'd like strange birds to hang around long enough for me to see them."

He sighed. "If you'd . . . "

Yes, she could have gotten up and looked. She wasn't being fair, and she knew it. Still, her voice rang with that stiffer gauge of steel she sometimes used when technicians, especially those who

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held doctorates as certificates of competence, made a royal mess of something critical: "I want that goddamn Chickadee gone. What normal birds it doesn't eat, it scares away." Andy stared at her, his eyes wide; this was a side of his mother he did not often see. She shook her head sharply, her hair swirling around her ears, and turned away. On the job, she could be pure boss, a tyrant on occasion as nasty as Ralph Chowdhury at his worst. Here, at home, the situation was contaminated by emotions that never arose in the lab. She felt a tremor in her throat and a moistness—tears—hovering behind her eyes.

She checked her watch again. It was time to go. If she lingered to argue, she would be late. "Just call."

"Watch," said Alan Bryant. "We can get the kangaroo sequence from San Diego." The only marsupial whose genes the commercial gene banks had proved to carry had been the common opossum; their stock was drawn almost exclusively from plants and animals common in the northern hemisphere. He had had to turn to the zoo's more specialized bank, which supplied gengineers around the world with the basic components of more exotic species.

He was sitting at the computer workstation in the lab. Emily was leaning over his shoulder, staring at the depiction of the Bioblimp's genome on the screen. Several lines, each one coiled upon itself to avoid tangling, represented the genimal's several chromosomes. Individual genes were identified by labels. Alan pointed. "It fits in right here. That puts it under the same control sequences as the tentacles, and then . . ."

He wore on his right hand a mouse, a glove that was the lineal descendant of the ancient computer control device that had first borne its name. Now he pointed, used his thumb to press a switch set against the side of his index finger, and pointed again. A line segment, marked "Pouch," moved in position beside the chromosome he had indicated. The chromosome broke, the "Pouch" gene moved into the gap, and the break resealed. He tapped the keyboard, used the mouse to choose the "Simulation" option on the menu that popped into view, and leaned back in his chair.

An egg divided. An embryo grew, hollowed, added a dozen tentacles, and began to show grooves in the side of the gasbag above each tentacle's base. The grooves became slits, and then pouches, and the genimal was complete. A new menu appeared, Alan chose "Animate," and the tentacles began to flex and twine. A simple cube sprang into existence on the screen. A tentacle picked it up and stuffed it into a pouch.

"We still need sphincters," he said. "To seal the pouches when they're full."

Emily straightened, one hand on the small of her back. "Very pretty," she said.

Alan rolled his chair back from the terminal to face her. "But," he said. "I can hear it in your voice."

She nodded. "You've done some real good work. But there are just too many pouches. They're too small to work for a moving van. Give it just two, one on each side."

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"That'll violate the symmetry," he said. As the new design now stood, the Bioblimp's growth-regulating genes would make it grow a pouch every time it grew a tentacle. Getting around that would be tricky, for it was difficult to mix radial and bilateral symmetries in a single organism.

"You can do it. Give the gene a new control sequence. Let the first two openings set up a gradient that inhibits other openings and breaks down the walls between pouches. Or we can cut the walls later."

He was nodding when the phone rang. It was Miss Carol at the desk downstairs. Detective Bernie Fischer was there to see Dr. Gilman. Was she available?

By the time Emily led the police officer back into the lab, Alan Bryant was intent on his screen. A glance let her see one hand moving sporadically over the keyboard, the other, the one wearing the mouse, twitching back and forth. He was clearly struggling with the task she had set for him, but from the small, satisfied grunts that issued periodically from his lips, he was making progress rapidly enough to please him. She expected it would please her as well.

She was silent as she led the cop to her corner of the lab, pointed him at the seat by the window, and poured coffee. Then, as he set his briefcase on the corner of her desk and began to undo its latches, she said, "You wanted to know about how we control our genimals, Detective Fischer?"

"Call me Bernie, Dr. Gilman." If voices could be seen and not heard, she thought, his would be a soft and mellow brown. Nick's, by contrast, would be orange, touched with red, a higher pitch, more brassy.

"Then I'm Emily. But . . . "

He withdrew from his briefcase a single glossy photo. She took it from his hand, and stared. "It's a chip," he said, "A PROM chip. A computer can read it but not write to it, though it is programmable with the right equipment. We have no idea what it does."

"From the Sparrow?" Her voice shook. She knew, too well, what the Sparrow itself had done.

"That's right."

"Where was it?"

"Plugged into the main board—the motherboard—in the cockpit computer. The federal people, from the Air Board, have the original."

"What does it . . . ?"

He shook his head. "They haven't analyzed it yet. I was hoping. . . . "

She stared at him. Nick was so slender, nonmuscular, almost as willowy as convention would have a poet. This Bernie was a sturdier soul, clearly of an age with Nick and her but thicker in the middle, stronger, more . . . more *masculine*. When he gestured with one of his large, square hands, she imagined his touch on her, on her breasts, her thighs, her . . . Her skin felt warm. Yet his appeal was not solely physical.

She, too, shook her head, though more abruptly, and her hair flew around her ears. "I can't tell you much from a photograph," she said. "But I can tell you what it might have done, what the possibilities are."

"Please," he said, smiling. He sipped his coffee. "That's all I want."

She touched a switch and the screen

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of her own desk-top workstation lit up. Her fingers rattled briefly over the keyboard. A schematic diagram appeared. "This is a Hawk," she said. "Like yours." She pointed. "There's the brain, the spinal cord, the motor centers. There's the passenger pod, the driver's console, the controller. A cable, here, from the controller to the interface plug under the forward lip of the pod. Wires from that to the brain." She explained how the controller, a computer, translated movements of the control yoke and the throttle and brake pedals into electrical signals and routed them as appropriate to the jets or the genimal's motor centers, triggering the genimal's own nervous system into commanding its muscles to serve its driver. All the necessary programming was built into the hardware, burned into PROM chips like the one pictured in his glossy.

"It's only a little different," she added, "in a genimal whose passenger compartment is built in, like a Tortoise. There the controller cable could go directly to the brain, without an interface plug, though there is one to make maintenance easier. A Roachster's plug is installed beneath the shell-secreting membrane, so molting will not affect it. To get at it, the techs have to cut through the shell."

He had nodded periodically as she talked, as if he understood it all. Perhaps he did. Now he said, "But the chip?"

She felt her face grow warm. She had forgotten the point. "Anywhere in this pathway," she said, pointing again at the circuitry of the controller. "Insert it, and it can lock out the driver. Then it can cancel legitimate commands and substitute its own. And its own commands might be very simple. That Sparrow—I think a block on the pilot's commands, plus a trigger to the jet's hunger center, might be enough. Especially if there were a timer on the chip so it turned on only at a specific time, or when a source of food, such as the expressway, was in view."

She paused reflectively. "You could try to prevent this sort of hijacking by putting feedback circcuits in the controller. They would check that the proper signals were getting through, but a chip could fake those, too. There really isn't any way to block such a thing."

He leaned forward, studying the screen. "Couldn't you make the beast smarter?"

She shook her head. "Uh-uh. Intelligence just isn't that easy to produce. They've been trying for a century to produce it in computers, and we haven't made any better progress with the genimals."

"But what about transplanting human genes?"

"That's the other reason why we don't have smart genimals. There are sixty different humane societies out there, and when they got together, they had very little trouble persuading Washington to ban transplanting human genes to genimals. They said it would be reinventing slavery. So, for that matter, would be gengineering a nonhuman intelligence." She hesitated before adding, "They're probably right. At least, if we're talking human-level intelligence."

He grunted as if to say he was listening, but his attention had turned back to the computer screen. With one blunt

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finger, he was tracing the circuitry she had tried to explain to him. Finally, he shook his head. "I can't picture it."

"Then I'll show you." She sighed, reached out a hand, and pulled him to his feet. As they crossed the lab, she said, "Alan, we're going out to Ralph's prototype barn."

Emily and Bernie heard the flat cracks—one, a pause, another, a pause, a third—as they approached the barn. Bernie immediately identified the sounds as gunshots, drew his pistol from beneath his uniform jacket, and ran to the door. Emily followed so closely that she clearly heard him yell "Freeze!" and something clatter as it hit the floor.

When she entered the cavernous room that housed the Armadon, she saw Chowdhury, legs spread, arms above his head, facing into the corrugated, scaly flank of his genimal. He was standing between its two waist-high left wheels, his arms straddling a doorway set into the bulge of the beast's side and back. Stubby legs twitched beside his shoulders. The genimal's long snout was bent back toward him, audibly sniffing, eyes blinking, tongue flicking. The long tail switched back and forth, stirring the hay that littered the barn floor. Above Chowdhury's head, ample windows set into the beast's side revealed an empty interior. Chowdhury was sweating, and his muscles trembled visibly.

"What were you doing?"

"Trying to startle it." Chowdhury's voice was weak, but it strengthened as he glared at Emily. "I wanted to see whether I really would have to take the time to grow a new prototype."

Emily spoke to the policeman's back. "We warned him that it might kick its legs off." She briefly described the armadillo's startle reflex.

Bernie laughed. "Look," he said, turning toward Emily for the first time since she had entered the room. "It's just a .22. A popgun." He retrieved it from the floor near his feet, aimed it at a bale of hay near the wall, and pulled the trigger. The noise was unimpressive. "My magnum, now . . . " He grasped his pistol in both hands, aimed, and fired.

The Armadon convulsed. Chowdhury flew across the floor to land on his back, spectacles askew, eyes wide. There was a loud crackle, as of breaking wood or bone.

Emily helped Chowdhury to his feet. "I'm sorry." She did not say, "I told you so." The point was far too obvious, for now the Armadon rested on its belly, its feet unable to reach the floor. Its tail quivered, its snout twitched, and a soft, panting whine crept from its throat. One of its wheels had rolled across the barn to fetch up against a wall, looking much like a wagon wheel decorating the set of a Western movie. The other three splayed from the Armadon's bulk, still attached by shreds of bone and skin, but useless.

Bernie stared sympathetically at the genimal. It had feelings, he knew, but . . . "You needed something louder," he said.

The other man straightened his glasses. He stared at the damage. He trembled harder. Then he took a deep breath, clenched his fists, and screamed at them: "What are you doing here?"

Emily laid a hand on his rigid arm as

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if to calm him. He shook it off. She said, "I wanted to show him how a genimal's controller works. He's investigating the Sparrow attack on the expressway."

Chowdhury spun around to stare at the cop. In a moment, he said, "So show him. Then get out of here." He turned his back on both of them. The Armadon whined again. He stepped to its side and laid a hand on its flank. After a moment he stalked toward the door into the lab that shared the barn building, leaving them alone with the crippled genimal.

Bernie returned his gun to its holster. "Touchy, isn't he?"

"Almost always." Emily patted the still whining Armadon's flank, opened its metal door, and waved him in. The door remained open behind them, and the windows in the genimal's sides gave them a clear view of the outside room. The cabinet that held the control computer, obviously not fastened down, stood askew. Emily presumed it had been jolted out of position when Bernie had startled the Armadon. A control tiller jutted from the cabinet, and a single seat, a cylindrical hassock, lay on its side nearby.

Emily stood the hassock upright, sat down, and removed the front panel from the computer cabinet. Then she repeated the lesson she had begun indoors. Now he nodded repeatedly, understanding what she said as long as he could see and touch a three-dimensional reality rather than some baffling, lifeless diagram.

Absorbed in their work of instruction and absorption, they nevertheless heard the door to the lab open and close and noticed when Chowdhury came to stand, listening, by the Armadon's doorway. Emily felt his presence as a weight upon her back. Eventually, she turned to include him in the conversation and noticed the syringe in his hand. It held at least a pint of clear yellow fluid. "Bernie says they found a foreign chip in the Sparrow, Ralph," she said. "I've been showing him how such a thing might work. It probably had some sort of internal timer."

"It's like a virus program," said Bernie. "It sits there in the computer, just waiting for its moment, and then it takes over."

Chowdhury snorted, scowled, and shook his head. "It wouldn't work," he said. "There are too many redundant pathways between the controller and the genimal. No chip could possibly block them all. And anyway, it couldn't hold a program for anything as complex as what the Sparrow was doing."

Why, wondered Emily, should redundant pathways make any difference? It should be electronic child's play to program the chip to intercept them all. She said nothing about that objection, however. "It wouldn't have to," she put in. "The controller doesn't control a genimal move by move anyway. It activates coordinative structures in the nervous system, hierarchies of reflexes and instincts that make it do what we want it to do. So why couldn't this chip simply activate a different set of instincts? Or even a single drive, such as hunger? Instincts and drives we normally want suppressed?"

Chowdhury opened his mouth and aimed the reflections from his spectacles at her alone, but before he could speak,

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Bernie said, "A chip like this would be lovely for criminals and terrorists—for hijackings, murders and assassinations, robberies. . . . "

"Bah!" Chowdhury held his syringe up as if to be sure they saw it. His open hand slapped the side of the door. The Armadon twitched beneath them, sensitized to such noises by its recent painful experience. "You are talking nonsense. Criminals don't have the facilities! And I will thank you to leave my Armadon now. Out! It is suffering."

Chapter Seven

As soon as Andy had eaten his breakfast, he had returned to the window to watch the Chickadee. Nick watched him with a smile, while he finished his coffee. The gengineered birds were familiar to the boy, but this one was in his own backyard, and it was real.

Nick could hear the voice clearly, so much deeper than a wild chickadee's that the normal "dee-dee-dee" became a "doo-doo-doo." He knew Andy could see the details—perhaps especially the alertly gleaming eye beneath the shaggy black skullcap. He could hear his son muttering—"Zoom! Whee!"—and knew that he was fantasizing about hopping onto its back and flying off to high adventures. He could be Sinbad, the Little Prince, Aladdin, Superman, any hero, every hero he had ever seen flying on the veedo shows or in books.

Nick left the boy to his dreams. He brushed crumbs from the breakfast table into his cupped hand, washed the breakfast dishes, and checked the refrigerator and freezer to see what he had in stock that might make a decent dinner that night. He added to the grocery list and checked his wallet to be sure he had the cash he needed. Then, with a glance at Andy—he was still absorbed in the Chickadee—he went to the small room he called his office and turned on his word processor.

He had been reading *Hey, Mabel!*, Jennie Bone's recent book on the tabloids and the magazines that followed in their tracks. Bone—years before, in school, she had been one of his professors—had quoted a long-dead tabloid editor to show why those rags never seemed to die: any story, true or not, that could make a husband cry, "Hey, Mabel! Dja see this?" would sell papers. Nick had appreciated her pungent views of the tabloid-readers' minds, and upon reflection he had said as much in a single poem.

But it had taken him a month to get that far. Andy was a distraction, as were all the chores of running a home, but those were by no means all the reasons for his slow progress. He sighed. He simply did not have the drive to be a successful writer.

He flicked off the machine. Speaking of chores, and of drive, or driving. . . . He checked the kitchen; Andy was still at the window. "I'll be in the garage."

"Sure, Daddy."

The garage. The Tortoise's stable. There was the food bin, the water, the tools for mucking out. Some families had larger garages, with two—or more—vehicles, and their own litterbugs to keep the floor clean. Someday, he and Emily would have as much. Right now, even if they could afford a litterbug, one Tortoise was not enough to keep it fed. They would have to supplement its diet, and that would cost

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more money. Emily's pay was ample, but so much of it went for taxes and insurance and to repay the loans that had put them both through school. He wished he had had the sense to study something more employable.

He replaced his shoes with rubber boots from a wall-mounted cupboard, positioned the wheelbarrow near the pile of grey-streaked paste, and muttered to himself that a reptile's crap didn't look much like a mammal's.

He fleered, raising his upper lip and exhaling gustily like an animal confronting some awful stink. Then he laughed at himself—he *was* an animal, and the mess *did* stink—and began his labors. To escape the smell as best he could, he breathed through his mouth.

When he returned inside, Andy cried, "Daddy! It's looking right at me!" And indeed it was. He stood behind his son and watched the Chickadee, a foot away, separated only by the glass of the window, twitch its head back and forth, first one eye trained on the boy, then the other. What was it thinking?

"Get away from the window, kiddo." Window "glass" had been replaced by a harder, tougher polycarbonate plastic in the days of his grandparents, but the word and the image persisted in people's minds. Besides, the Chickadee's beak was the size of a kitchen wastebasket. Its tip and edges looked quite sharp enough to smash even plastic "glass," and then to do far more damage than he could stand to contemplate. He laid a hand on his son's shoulder and tugged.

Andy looked up at his father with all the scorn a five-year-old can muster for a too protective parent. "Oh, Daddy! It's not going to eat me!" To his mind, the incident on the expressway had no bearing on the rest of life. Besides, that incident had not really touched them. Nick, like Emily, felt differently.

"Come on. I'm going to call the airport." He drew the boy away from the window. As he did so, the Chickadee stepped back itself, as if it could have heard and understood his words. When he picked up the phone, it launched itself heavily into the air, its wings straining. It was clearly, even to Nick's untrained eye, just about at the limit for unassisted flight.

The Chickadee didn't go far, for Nick could hear its feet scrabble on the roof. With nothing to watch, Andy wandered into the living room, turned on the veedo, and sat down on the thickest of the several throw rugs scattered over the polished hardwood floor. He lay down on his belly and stretched an arm under the couch to retrieve a toy, a small metal truck that had somehow survived Nick's own childhood.

The airport Nick called was not the regional jetport he had visited to pick up Emily. It was just a few miles away, a much more local affair that catered to the owners of private one- and two-passenger jets. He had driven past it several times, remembering the few lessons he had once had on mechanical airplanes and wondering if they could afford a few lessons on these modern aircraft. He had seen that the airport was small and shabby, but not so derelict that most of its planes could not be kept in small hangars. A few jets were tethered in the open. He would have thought the Chickadee one of the latter, except that there was no broken tether cord around its neck. Perhaps it was kept in a hangar,

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but its owner carelessly failed to latch the door.

The airport clerk sighed with audible impatience. "You called us yesterday, didn't you?"

"That's right. And you came and got the thing. Now it's back. On the roof."

The clerk sighed again. Jets weren't supposed to take off on their own, but sometimes they did. Or the small ones did. The big ones couldn't, and Nick should be thankful he didn't have a Sparrow on the roof.

When Nick grunted, the clerk said hurriedly, "I didn't mean . . . If you were . . . "

"I was."

"So was my sister, and she won't even go in the park now. The pigeons." The clerk's tone was instantly more sympathetic. "We'll get someone right out there. It might be an hour or so, but we'll get that jet off your roof. Yes, we will."

From the walk in front of their house, Nick and Andy could see a streak of birdlime running down the slope of the roof. A glob of the stuff had beaded there, while the rest had fallen, some of it hitting the brick side of the house beside the bedroom window, all of it spattering over the rhododendrons below. He would, Nick thought, have to hose it off later, or it would burn the shrubs, or even kill them. Fertilizer belonged in the soil, not on the leaves.

The Chickadee was still on the roof. Its head jerked this way, that way. Its tail pumped at the air, compensating for the head movements that might have thrown it off balance. Swallows swirled around its head, trying to drive it from their nesting territory. Occasionally, it seized and ate one.

"Yuck," said Andy, and as if noticing his disapproval, the Chickadee spread its wings and hopped into the air, flapping, gliding to another rooftop down the block. Nick hoped that it would remain in the neighborhood until the airport crew could get there.

"C'mon," he said. "Let's go get those groceries."

"I'll get it!" Nick smiled as Andy dashed into the garage to lift their folding wire cart from its nail. Without it, they would need a cab to bring the groceries home. With it, the walk home would be only a little more labor than that to the store. It would be much less if Andy would not insist on helping him to pull it along the walk.

But before they left . . . A large oak tree overhung one corner of the front yard, its branches drooping with the weight of leaves. For some reason, Nick turned to stare at it, his eyes scanning the limbs revealed in shadows by the shifting of the foliage. There, the streaks of orange in its plumage spoiling the camouflage that might have worked quite well in a swamp, was the strange bird of breakfast time. It held a bittern's posture, tapered body still, beak upthrust, eyes blinking. As he watched, it twisted on its feet as if to let its gaze sweep over the front of the house.

Nick shuddered. "Let's go, kiddo."

Nick was in the kitchen, in the back of the house, when he heard the garage door close. Footsteps sounded on the walk, the front door's latch clicked, hinges squeaked, and the footsteps vanished as they touched the throw rug in

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the front hall. A clunk announced that Andy had dropped his toy, and there was a glad cry of "Mommy!" Emily's briefcase struck the floor with a soft thud. Nick could tell when she bent to kiss their son, for there was a soft creak as the fabric of her skirt stretched across her butt.

He sliced the last potato half, arranaged the slices in the pan—they would have scalloped potatoes tonight, with fried tofu and salad—and set down the knife. He blinked away the odor of the onions he had sliced first and rinsed his hands. He opened the refrigerator, took out a carton of white wine, and poured two glasses. Then he stepped into the living room and saw, just as he had imagined, his wife was scooching, one knee on the floor and the fabric of her skirt drawn tightly over one haunch. She was hugging Andy, and her dark hair fell forward to curtain her face, and the boy's, from his view.

"Hi, honey." He held one wineglass out to her.

She looked up, her eyes narrowing, her mouth as hard and tight as if there had been no hiatus between this moment and the morning. "Did you call?"

"Sure. It's gone, and I saw that strange bird again. You'll get to see it. Good day?"

Her mouth finally softened. She accepted the wine. She smiled at him, and he remembered when he had first seen those wide, expressive lips. He had been with another girl, at a party in a dorm, when a gust of laughter had drawn his attention to the other side of the room. There she had been, enjoying the joke, her mouth all teeth and tongue and happy noise, and her date—Nick had seen it—had slid a hand over the seat of her jeans. Her face had closed in, turned dark, erupted with her fury. There had been a slap, a curse, a stalking away. And when he noticed her again, in some unremembered class, he had asked her out. He had long forgotten the name of his date at that party.

Why had she appealed to him? Had he seen her fury as a challenge? Had he thought, someplace within his mind, out of reach of any conscious intent, that he might be able to please her more? If so . . . He smiled back at her now. He lived for those sunny moments, fully aware that she could get mad with little notice and over what he, at least, thought were only minor slights. What's worse, her anger could last for hours and days, until the world—or he—finally bent to her will.

"I'll know for sure when Alan gets those kangaroo genes installed in the blimp."

Nick laughed. "The cargo pockets?"

She nodded. "It looks like they'll work." She paused, ruffled Andy's hair, and stood up. Then she added, "We had a cop at the lab today."

"I hope he wasn't suspecting you of anything." Nick led the way into the kitchen.

"Can I have a sip?" Andy, toy truck in his hands, was staring at his mother's glass. It was something of a family ritual: whenever they had drinks—beer, wine, scotch, whatever—he could have one small sip from each of their glasses. They believed it could do no harm and might do good, if he grew up with the idea that alcohol was acceptable in small amounts.

As he busied himself with getting

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their dinner onto the stove, she said, "They found a chip in that Sparrow's control computer." She had, she said, explained to the detective how such a chip might preempt control. She did not give the cop a name, or say that Nick had met him on the expressway.

"I took him out to Ralph's lab," she said, and laughed. When Nick turned toward her, face poised in inquiry, she was sitting at the kitchen table, drink in one hand, her gaze aimed toward some vague place beyond the walls of the room. Yet she noticed his expression and drew her attention home again. She added, "I kept a straight face then, but . . . " She explained that she had told Chowdhury that the armadillo's startle reflex would give his Armadons problems, and they had caught him checking the idea out with a small pistol. She described the scene and its outcome, and Nick laughed too.

At the same time, both of them shook their heads ruefully. The situation had clearly had all the slapstick humor of a pratfall. But like any pratfall, no matter how ludicrous, it had involved pain. Pain for both the Armadon and its creator.

If he wondered that his wife seemed to be dwelling on another man, he said nothing. She showed no sign of romantic or sexual interest, and besides, modern marriages varied broadly in their openness. Some couples orbited each other only loosely, returning home like explorers to a base camp. Some, like Nick and Emily, hewed only to each other. Yet, he knew, neither of them had ever tested their bond. If and when such a test arose, their marriage might have to change.

* * *

Later, once Andy was in bed and asleep, they had another drink. They read a bit in separate easy chairs. Then they shifted to the couch, side by side, his arm around her shoulders, one hand playing with her buttons, her hand against his chest toying with his, to watch a veedo show.

The show proved boring, but one button led to another. Soon they tuned the veedo's sound to a low murmur and paid attention only to each other:

"Do all poets have quill pens?" she began. "Feathers here . . . "

"Ballpoints."

"Fountain pens."

"Gengineers have test tubes."

"They need genes too."

"How do they get them?"

"With pipettes." A pause. "Did you know that lab workers used to suck on pipettes. With their mouths?" They shifted their positions, and there was a longer pause. "But now they're safety-conscious. They use electronic pumps."

"Poets use electronics too."

"Not tonight, they don't. We want those genes. . . . "

"Put that pipette . . . "

"In the test tube . . . "

"Click that ballpoint . . . "

"Fountain pen!"

They had perfected the game long ago, when they were still in school, before they were ever married. Still they loved to play it.

Chapter Eight

What had awakened her? Morning light—*early* morning light—filtered past the curtains. The clock radio had not yet turned on. There was silence from

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Andy's room. Nick was still, his head on her shoulder, his breath warm on her chest, his hand spread on her belly. She twisted in the bed, let his head fall to the pillow, and smiled tenderly at his oblivious face. He had always been a heavy sleeper.

What had awakened her? Some sound? She peered at the clock across the room: its glowing numerals announced smugly that the time was a quarter to five in the morning. It would be another hour before the radio turned itself on to get them out of bed.

But there was light. Dawn was breaking outside, and there was no bird song. Was that what had awakened her? That absence of normality? That silence?

No. A soft crunch sounded overhead, a scritch of avian claws as they stepped along the peak of the roof.

That goddamn Chickadee!

"I believe you," she said. "You said you called the airport, and you said they came and got the Chickadee, and I believe you. So why is the damned thing still here?" Her voice was so tense it was almost a scream. "I want it *gone!*"

"Me, too!" said Andy.

Emily suppressed a glare at her son. Like most children she had ever met, he did not know what to want for himself. He learned, he built himself, by using those who meant the most to him as models. He was heartbreakingly loyal, and there were times when that loyalty made her heart turn over in her chest. But right now he was staring yearningly at the window, clearly wishing that the Chickadee would come down off the roof for him to watch. His loyalty was so obviously just that, no more, unreal, a lie for whatever in-built reasons, that, for a moment of irrationality, she wanted to strangle the little bastard.

Her toast and juice sat untouched before her. Her coffee quivered in its cup when she lifted it to her mouth. A swell of tears hovered on the brink of her lower eyelid. She dabbed at the moisture with a hanky from the hanky bush.

Nick stared at his plate. Yes, he had called. Yes, they had come. When he and Andy had returned from their shopping trip, Mrs. Palane across the street had said so, describing the truck, the crew, the bait that had lured the bird into the truck, and the sigh of relief that had seemed to emanate from the trees, where presumably the local—and diminished—population of swallows was hiding out. If he wasn't sure about the sigh of relief—Mrs. Palane did have a tendency to hyperbole—he did believe the airport crew had come for the Chickadee. But, yes, here it was again. He had clearly failed.

He said: "They can't be securing it very well."

"I'll say! This is the second time it's come back!" She jerked her head sharply to one side, making her dark hair fly as if to emphasize her anger.

He explained why he didn't think they were tethering it at all. "It has to be a hangar bird, and the hangar door can't be latching properly. Either that, or someone is letting it loose at night."

"Don't tell me about it. Tell them!"

"I will." He set down his cup, brushed a crumb from the front of his white shirt, carried his empty plate to the sink, and made the call on the spot. He didn't want her doubting him, or

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accusing him of more failure than he had earned. She was, he thought, too prone to anger, even with a good excuse, and he felt his real failures keenly enough without her comments.

The airport clerk, once more, was sympathetic and promised immediate action. Nick suggested that once they had the little jet back, they check the latch on its hangar. He did not suggest that anyone was letting the Chickadee out deliberately, for that seemed unlikely.

When he was done, his wife nodded as if he really had solved the problem. She took a bite of her cold toast, drank her juice, and pushed the dishes away. Then she said, "It's time to go."

"I'll go out with you."

She shrugged, as if to say, "Suit yourself," and left the room for her briefcase. Andy followed, stretched to reach the garage door control, and held the door for his parents.

Together, they waited on the walk while the Tortoise ambled from its cave and positioned itself for boarding. But Emily did not board. Instead, she stared at the Chickadee on the roof, and her mouth set in a rigid line. The bird shifted its weight from one leg to the other. A shingle came loose, slid down the slope of the roof, and fell among the rhododendrons.

"And now the roof is going to leak," she said.

"I can fix it," said Nick. "I will."

"But look at that!" She pointed at the streak of birdlime. "Look at *what* it's going to leak!"

Nick laid a hand on her arm. "It'll wash off the roof. I'll take a hose to it today." With gentle pressure he turned her to face the oak that overhung the lawn. He pointed. "But look there."

"Where?" She searched the shadows among the great tree's branches.

"There!" cried Andy. "I see it!" Nick lined his arm up beside her head so that her gaze could follow its line.

"Is that it? It's pretty." The strange, bittern-like bird was there again, or still, its beak thrusting into the shadows above its head, its small eyes, like beads of sparkling ebony, blinking in the morning light.

Now that bird turned, focusing those dark eyes upon them. Its beak swung to the horizontal. Its wings lifted as if in a shrug. They flapped once, twice, and it dove off its branch. Its course carried the bird, a heavy flier, low over the lawn before it could rise and circle close above their heads.

"It's right over you, Mommy!"

Indeed it was. It was so close that they could feel small gusts of breeze from its straining wings, and the shadows of its passage across the Sun were passing waves of coolness. But now its circle was rising and broadening, and its eyes seemed aimed at Emily alone. She moved to one side, and the bird's orbit shifted to remain centered on her. The Chickadee moved too, cocking its head to watch the little drama below it. It sidled along the rooftop as if to be closer to the action. Its beak gaped, and in the brief glance she spared it, Emily could see the tongue within its mouth.

The strange bird suddenly broke off its circling, uttered a raucous shriek, and dove straight for Emily, its beak an outthrust dagger. Andy screamed. Nick grabbed his wife and pulled her toward

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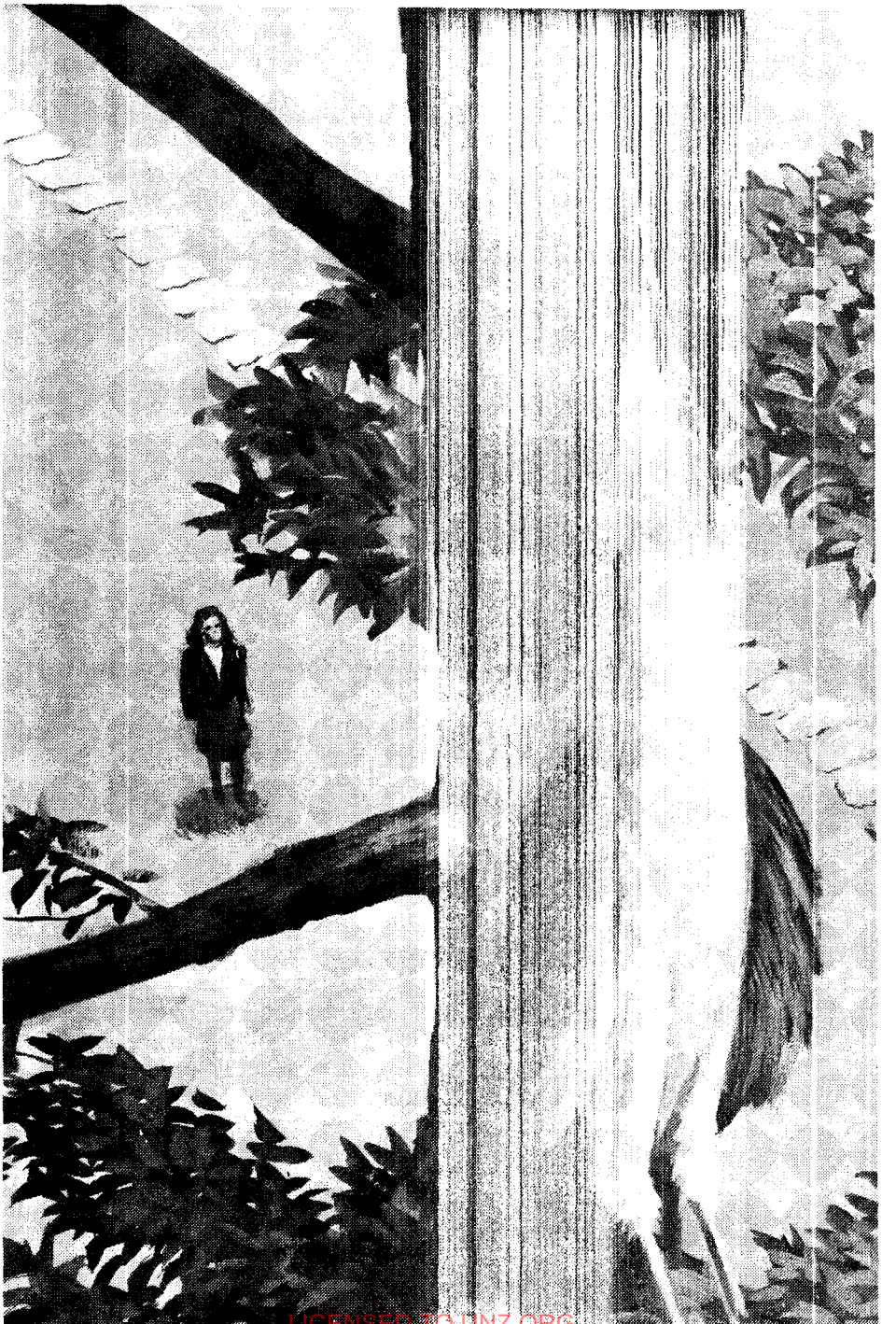

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him. She felt the buffet of the bird's heavy wing against her arm as it missed.

It did not give up. As Andy, still screaming, grabbed his mother around the legs, hobbling her as effectively as quicksand, and as Nick, cursing, tried to pry him loose and get them all into the house, the garage, the Tortoise, anywhere safe, the bird bent its course around again. It flew up between the oak tree and the house, performed a graceful Immelmann looping turn, and arrowed back toward the target it seemed to have chosen so deliberately.

This time, it did not make it. It did not even come close. Its course took it over the roof of the house, and as soon as it was within reach, the Chickadee lunged and caught it by one wing.

The smaller bird swung on its suddenly forced pivot. There was a snap of breaking wingbone. It struck with its beak, stabbing, and the Chickadee's throat blossomed red.

The Chickadee cried out in apparent pain. As its beak parted, the bittern—if that was what it truly was—fell to the roof, its beak and one good wing flailing. One huge foot clamped it into place, while the Chickadee's shorter, blunter beak struck once, twice, three times. As blood spattered on the roof, Emily felt a droplet of something wet and cool strike her cheek. Another droplet struck Nick's white shirt, and she knew that hers, too, must be blood, blood that had lost its warmth in its voyage across the intervening space.

The Chickadee cried out once more and leaped, more clumsily than usual, into the air, leaving its victim behind. It flew off, heading this time in the direction of the airport, presumably going home to nurse its wound.

The dead bittern slid slowly down the slope of the roof to land in the shrubbery. It was accompanied by two more broken shingles.

Nick finally got Andy loose from his mother and scooped him up to hold him safe, his thighs enwrapped by one paternal arm. The boy began to cry. "Let's go back in the house," said Nick. With his free hand, he tried to steer Emily toward the door they had just left.

"No," she said. She patted his hand with her own, understanding his protective feelings. But she was a biologist, a genetic engineer, and she had just been attacked by something whose behavior was not natural.

She looked down, at the hand that still gripped the handle of her briefcase, and noted without surprise that her knuckles were stark white. Deliberately, she loosened her grip, scooched, opened the case, and extracted a tissue. She dabbed at her cheek, stared briefly at the spot of red upon the tissue, wondered which bird the blood had come from, and crossed the lawn to the bittern. Two rhododendron branches, broken from their parent bush, lay beneath the body. A pungent odor declared that that body had fouled itself as it died.

Emily used the bloody tissue to cover her fingers as she drew the bittern into clearer view on the lawn. Even in death, its orange-on-grey color scheme gave it a kind of beauty. But, close up, that beauty was the stark beauty of a weapon designed for a single job. Now, finally, when it had almost been too late, she recognized it.

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The back of the head bore a small, implanted plug of the sort that on the Tortoise received a cable from the controller computer. The beak was as long as her hand from wrist to fingertips, sharp, and stained, as if it had been dipped in some sticky substance. The claws were talons whose specifications probably had been lifted from the genome of a hawk or eagle. Around one ankle was a metal band.

A shadow fell over her. She looked up at Nick and Andy. "An Assassin bird," she said. "But why was it after me?"

The police arrived half an hour later. Nick had called them immediately, while Emily made herself and her husband another pot of coffee. Now here they were, their Roachsters hogging the driveway and forcing the Tortoise back into its garage. Nick, Emily, and Andy had been herded onto the walk by the front steps, where they would not interfere. The police themselves were stomping all over the lawn, taking samples of the Chickadee's dung, retrieving feathers of the Assassin bird from beneath the oak tree and the bird feeder, sliding the body, looking much smaller than it had in life, into a plastic bag. The officer whose responsibility was this last task was being very careful not to touch the beak.

Nick was explaining: "It showed up first by the bird feeder—my son spotted it—but then the Chickadee chased it off. . . ."

"A Chickadee?" The tone of disbelief that escaped around the officer's wad of gum was thick enough to bottle. It smelled of peppermint.

"An escapee from the airport. We thought this, this Assassin bird, was just a pretty bird. We looked it up and figured it was some kind of bittern. Then it showed up in the tree there. . . ." He pointed.

One of the cops, dark-skinned, grizzle-haired, with a weathered look to his lined face, kicked at Emily's briefcase, still on the ground, and said, "Bitterns don't roost in trees. They're a swamp bird."

Nick shrugged. So he had thought, Emily knew, but there the bird had been. "That's where it was today, too. And when we came out, it flew around her, in circles. . . ." He gestured overhead with one arm. "Then it attacked, and the Chickadee got it."

"So where's the Chickadee?"

"It flew off. I guess it's back at the airport."

A shadow swept overhead. They all looked up, and Emily said, "A Hawk!" The police insignia were plainly visible.

The Hawk, fanning its wings and tail, descended onto the lawn, braced its legs, and darted its head left and right. The bubble-shaped pod on its back opened, and a figure familiar to both Nick and Emily emerged. He waved to the other officers and approached the Gilmans, leaving the Hawk alertly scanning the neighborhood.

"Detective Bernie Fischer," he said to Nick. "We met on the expressway. Damned birds." To Emily, he said, "I thought I'd asked you every question I could think of yesterday. Now . . ." Someone passed him the bagged Assassin bird. He gestured with it. "This gives me a bunch more. What happened?"

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Nick watched Emily as she answered: "It was no accident, Bernie. It can't have been. Someone had to aim it at me. Me!"

She looked from the detective to her husband. If he had been a cat or dog, she thought, the fur above his neck and shoulders would have been bristling suspiciously.

"Wait a minute," Nick said. "This detective was the cop who interviewed you at the lab?"

Emily and Bernie both nodded. Emily said, "Why not? He found out I was a gengineer at the expressway, and then he needed to talk to a gengineer."

He was clearly unable to completely restrain his skepticism that that was enough to explain his wife's familiarity with the other man. But in a moment, he relaxed, and Bernie asked Emily again, "But what happened?"

She went through the whole story again, just as she had for the other cops. When she came to the Chickadee, Nick interjected, "I don't see how it could keep escaping. Maybe someone's been letting it loose on purpose."

"We'll look into it," said Bernie. Then, when Emily had finished her report, he asked her, "Why did someone have to aim this bird at you?"

"It's an Assassin bird. Programmable." She pointed at the plug in the bird's head. "The military uses them."

"Ah," he said. He looked at Nick. He shifted his gaze to Andy, standing between his parents. "Then we should be able to track it down. I'll get right on it." One hand lifted as if he would like to squeeze Emily's shoulder, but he redirected the intended movement toward the boy. "Your son?" As they nodded, he patted Andy on the head. "We'll protect your mother," he said. "That's our job."

Bernie lifted off in his Hawk shortly thereafter. With him went the Assassin bird in its plastic bag. After him went the other cops, leaving behind footprints, a cigar butt, and a handful of gum wrappers.

"Andy," said Nick. He made a show of examining his watch. "The Chickadee's gone. Isn't there a veedo show you like about now?" When the boy, thus reminded of his favorite *Warbirds of Time*, rushed toward the house and veedo, Nick added, "Should I be jealous?"

Emily bent to pick up her briefcase. She stared at him. She said, "At a time like this you can ask such a question?"

"The way he looked at you. . . . "

"And the way I called him Bernie?" Her wide mouth contracted into a disgusted moue. "Yes, we got fairly friendly yesterday. But not *that* friendly." She tucked her briefcase under one arm long enough to clap her hands once, sharply. The Tortoise emerged once more from the garage.

The door to the house opened suddenly, slamming against the side of the house. Andy yelled, "Daddy! Phone!"

"I'll see you tonight." Emily climbed into the Tortoise, and the vehicle began to move immediately. She did not look back. Nor did Nick, staring after her, yearning, resisting the pull of the phone, cry anything after her.

Only later did she learn that the phone call had been from the local airport. The Chickadee had returned just as the retrieval crew had been about to leave.

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Unfortunately, before they could get it back into its hangar, it had dropped dead. *What* had Nick done to it? *Who* was going to pay? And did he know, *he* could be arrested for destroying other people's expensive property?

As Nick told her that evening, it had taken him ten minutes to explain, though his explanation did little to soothe his caller. ■

CONTINUED IN THE NEXT ISSUE

IN TIMES TO COME

● Janet Aulisio's November cover is for J. Brian Clarke's "Flaw on Serendip," a new story set in his "Expediters" universe. That universe, as you may recall if you've read earlier stories about it, contains a great many planets linked by instant-transport "gates" built by a mysterious race known only through its works. The nature of those works is conducive to thinking of the makers as "god-like"—but even gods may make the occasional mistake and hope nobody notices. Those who *do* notice may learn things they would just as soon not have known. . . .

The fact article is about the International Ultraviolet Observatory (IUE), a satellite which is enabling astronomers to look at the universe in a new way that was not available to ground-based telescope. The author, Yoji Kondo, is in a good position to know whereof he speaks: he's the director of the IUE observatory at Goddard Space Flight Center.

We'll also have new stories by Timothy Zahn (another in the "Soulminder" series) and Amy Bechtel, as well as Part II of Thomas A. Easton's *Sparrowhawk.*

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Martyn J. Fogg

STELLIFYING JUPITER

You've read many items about terraforming—here's something a bit different.

Do you recall the ending of Arthur C. Clarke's movie *2010*? Before the astonished eyes of a group of American and Soviet astronauts, mysterious and godlike extraterrestrials implode Jupiter, turning it into an artificial star. This spectacular feat was not merely to "impress the natives"—although it did, World War Three was prevented—but was also intended as a first step to enable mankind to terraform Jupiter's Galilean satellites.

I don't know about you, but I left the cinema disappointed. I couldn't see how Clarke's method of stellifying Jupiter could possibly work. What I wanted to know was if Clarke was merely pulling a cosmic rabbit out of a very large hat, or whether there was actually some scientific rationale (however nebulous) for the ending of the movie. So I wrote to him, only to hear by return that Arthur cannot now recall what was going through his mind when he wrote *2010*'s genesis. Obviously, there was magic involved, of the type referred to in Clarke's Third Law: "*Any sufficiently advanced technology is indistinguishable from magic.*"

I was unsatisfied, even more so in fact as I had just finished reading Vernor Vinge's superb *Marooned in Realtime*. I enjoyed chapter eighteen; it was one of the most spectacular fictional views of the future I have ever read.

I found one quote particularly inspiring: "*Such a fine idea it was. Our parent company liked big construction projects. Originally, they wanted to stellate Jupiter, but couldn't buy the neccessary options.*"

Stellifying Jupiter—what a thought! But need we neccessarily invoke magic or "superscience"? The question I asked myself was, "Is there any feasible scenario for stellifying Jupiter permitted by modern astrophysics?"

Is Implosion an Option?

Before we start tampering with Jupiter, we should first ask ourselves how far away is Jupiter from being a star in its own right? Most astrophysicists are of the opinion that a star must be above

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about 8% of a solar mass for conditions in its core to be right for sustained thermonuclear fusion reactions. Below this mass we have "brown dwarfs," stars that burn deuterium, and other light elements such as lithium, to exhaustion as they contract and thereafter cool to near invisibility. No solitary brown dwarfs have yet been discovered and it is thought in any case that there is a lower mass limit to the formation of these hypothetical objects of about 2% of a solar mass. Jupiter is only a thousandth the mass of the Sun and so clearly is nowhere near being stellar. Any attempt to ignite Jupiter without substantially altering its physical parameters would doubtless fizzle out.

The collapse of a portion of Jupiter to enormous density is the alteration in Jovian physical parameters that Clarke appeared to be relying on at the end of *2010*. One of his astronauts speculates that Jupiter might even have been compressed to the density of neutron matter (about a thousand trillion grams per cubic centimter), in effect turning the planet into a low mass neutron star. How would this new star shine? Well, for a start, the collapse itself would release enormous quantities of gravitational potential energy. This would greatly heat the infalling matter, probably too much for comfort—an uncontrolled collapse would be the equivalent of setting off a miniature supernova in the middle of the Solar System! If this problem could be overcome, then one might imagine the final configuration of Jupiter as a central dense object surrounded by an accreting shell or disc of hydrogen. Whether thermonuclear reactions in this shell would proceed smoothly or episodically is anyone's guess.

The collapse scenario has major problems. It is almost impossible to envisage how the implosion of Jupiter might be achieved without resorting to magic It also appears that the postulated end-product, a Jovian mass neutron star, would not be stable. Many SF readers are used to the concept of small, handy, chunks of neutron matter, as many SF authors love throwing the stuff about to achieve all sorts of spectacular effects. A grapefruit-sized chunk of it would weigh about half a trillion tons: no wonder it's irresistible! However, the only bulk neutron matter we think may exist in nature is within neutron stars and the curious property of these stars is that shrinking them in mass results in an *increase* in their radius. In other words, low mass objects made from neutron matter are *less dense* than higher mass objects. This implies a minimum mass limit for objects made from neutron matter, below which gravitational compression is not sufficient to prevent neutron decay back into protons and electrons. Current models of neutron stars suggest that this limit is from 3 to 18% of the mass of the Sun. Thus we can see straight away that Clarke's densified Jupiter would probably "bounce" and re-expand. Thus, magic would also be needed to maintain Jupiter in its required ultradense state!

Can we confidently say therefore that stellifying Jupiter looks at the present time to be totally impossible? Not nec-

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essarily. An alternative way to stellify the planet may be to not collapse Jupiter, but instead to *introduce a collapsed object into its core*.

An Exotic Power Source for Jupiter

We are obviously now talking about a small black hole. How might this provide the energy output to stellify Jupiter?

A black hole is created by the collapse of an object to such a density that the intensity of its gravitational field prevents even photons from escaping its surface. By "surface" I refer to the event horizon: the boundary surrounding the black hole, cutting it off from the rest of the Universe, where the escape velocity is equal to the speed of light. Normally, black holes are thought to be created by the collapse of massive stars. However, numerous small holes of sub-stellar mass may have come into existence in the first moments of the Universe—I'll return to these later.

Because black holes have such concentrated gravity fields, they thus strongly attract any matter in their vicinity. As matter falls into the hole, gravitational potential energy is released, resulting in phenomenal heating and the production of an enormous flood of radiation. That's the simple picture—but what size of hole would we need to stellify Jupiter and how might it behave inside a planet?

To answer this we will have to look at *accretion power* in more detail, but not too much! The whole subject is immensely complex and still clouded in a great deal of uncertainty. A realistic study of black hole accretion must take into account, amongst other things, the temperature, density, angular momentum and composition of the infalling matter; the presence of magnetic fields; thermonuclear fusion of matter compressed close to the hole and both the hole's rotation and its relative motion with respect to the medium it is passing through. Scientists have considered accretion onto black holes within a number of astrophysical contexts, but nobody, to my knowledge, has looked at intraplanetary black holes. This is hardly surprising, somebody would have to *put* a black hole inside a planet; this is not the sort of trick performed by nature!

OK, it's complicated, but let's try to ease our speculation by looking first at three generic types of black hole accretion that have been modelled.

1) *Spherically symmetric accretion.* To simplify the problem, early studies of black hole accretion assumed infalling gas had no angular momentum with respect to the hole and that the hole was stationary and non-rotating. Infall of matter would therefore be spherically symmetric. The closest to this idealized situation in nature would be an isolated black hole accreting from the interstellar medium. It turns out that this mode of accretion does not heat up the gas very well (in some models infalling gas actually cools within a certain distance from the hole) and so it would not produce very high luminosities. Estimates for the conversion of rest-mass energy to radiation in this case range from very low values to up to 2%. For comparison, thermonuclear fusion is about half a percent efficient, so that in most cases

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spherically symmetric acretion onto a black hole would be no better than fusion.

2) *Disc accretion.* The behavior of accreting matter is quite different if it has some angular momentum with respect to the hole. Particles go into an orbit at the distance where angular momentum balances gravity: a swirling disc of hot gas—an accretion disc — forms. Since orbital velocities increase with decreasing distance towards the hole, shear within the disc gives rise to an enormous viscous stress that transports angular momentum outwards and allows particles to spiral inwards towards the hole. The disc, if you like, is being heated by friction and releasing its gravitational potential energy as an enormous flood of radiation. The efficiency of conversion of rest-mass energy to radiation in this case depends on the rotation of the hole: 5.7% for a non-rotating hole to 42% for a maximally rotating hole. These figures are much higher than the efficiency of nuclear fusion. *In fact, accretion power is the most efficient energy source known, short of complete matter-antimatter annihilation.*

Disc accretion onto black holes is thought to occur in two situations where infalling matter has a high specific angular momentum: accretion onto a central galactic black hole (one explanation for quasars) and accretion onto a stellar remnant black hole within a binary star system. Several X-ray sources that have been detected in space provide tantalizing evidence for the latter possibility.

3) *Eddington limited accretion.* When the accretion rate is very great the luminosity produced exerts a pressure on the infalling plasma and tends to retard the flow. Here's how it works . . . The photon force acts almost entirely on electrons, whereas gravity works equally well on protons and electrons. Hence electrons move outwards compared to protons, creating an electric field that transfers the photon force from electrons to protons. Thus the luminosity approaches a critical value, called the *Eddington Limit,* at which further accretion is prevented by radiation pressure. *Accretion becomes self-regulated.* The Eddington Limit is fundamental and applies to any gravitating mass. Its value for a particular body is directly proportional to its mass and, assuming the accreting gas is a very hot plasma, we can simplify the governing equation to the simple relation $L_{Edd} \approx 6.53M_H$, where L_{Edd} is the limiting luminosity in watts and M_H is the mass of the hole in kg.

Now we can make that stab at estimating the mass of the black hole that would be required to stellify Jupiter. It is reasonable to assume that within a dense planetary interior accretion onto the hole would be so great as to be regulated at the Eddington Limit. (This idea is not entirely original as in the 1970s Donald Clayton and others at Rice University, Houston, did consider the presence of a black hole in the center of the Sun, accreting at the Eddington limit and providing half the solar luminosity.) If we wish to create a habitable zone in the vicinity of the Jovian satellite, Europa, then we can work out the approximate luminosity required. It

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is about $4x10^{21}$ W, approximately one hundred thousandth the luminosity of the Sun, which would increase the surface temperature of Jupiter to a little over 1000 degrees Kelvin. With this value we can see that the mass of the hole would have to be about $6 x10^{20}$ kg, equivalent to the mass of a large asteroid and approximately one ten-thousandth of the mass of the Earth.

The Engines of Stellification

So, we now have an estimate for the mass of a black hole which, when emplaced within Jupiter, gives us the luminosity we desire. It is obvious that such a small hole could not form in the present Universe as its mass is far below that of any black hole formed as a remnant of stellar evolution. Where, then, should we look?

Most of you will know that in the early 1970s physicist Stephen Hawking proposed that numerous black holes, with a mass spectrum ranging from grams to many solar masses, could have formed from density fluctuations in the first seconds after the creation of the Universe. Hawking later showed that quantum processes cause black holes to evaporate in a manner that is an inverse function of their mass. Thus, the smaller the mass of the hole, the more rapid the evaporation, until in the final tenth of a second of the hole's existence it gives up its remaining mass-energy in an enormous 25 million megaton explosion! This means that all holes that started off with masses of less than about a billion tons should have disappeared by now. Although no primordial black hole explosions have been observed, their existence is by no means ruled out. The intensity of the diffuse gamma ray background radiation from space constrains the number density of these objects in the Universe as a whole to a maximum of about 300 per cubic light-year. This means that the nearest hole to the Sun would still be quite a long journey away. However, Hawking has pointed out that primordial black holes might be concentrated within galaxies by a factor of up to a million; thus the nearest hole may lie on average only as far away as Pluto.

If primordial black holes exist and the astronomers of future civilizations discover one of the requisite mass in the near-solar neighborhood, then we would have a "stellification engine" for Jupiter. However, first we have to get it inside the planet.

Shipping a Black Hole

Once a black hole of the correct mass is found it would have to be steered on a trajectory so that it impacts Jupiter with as low a velocity as possible. There are two ways I know of by which this might be done. An asteroid could be prepared for use as a "gravitational tug" by first steering it into orbit around the hole. Then, each time the asteroid is given a push, by mass driver propulsion for instance, the hole is pulled along with it. Another possibility was well described by Larry Niven in his SF short story "The Borderland of Sol." Here, a character wishing to use a primordial black hole for villainous purposes first gives his hole a net electric

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charge by allowing it to accrete the exhaust from an ion rocket. This would give the hole properties similar to an incredibly massive charged particle, which could be pushed upon and manipulated by powerful magnetic or electric fields. I find it difficult, however, to imagine this method being of any use for maneuvering a hole the mass of Ceres. In any case, charged black holes would rapidly become neutralized by attracting particles of the opposite charge.

Moving a small black hole might look difficult, but getting the thing to stay inside Jupiter would be a real headache! One might hope that the hole would experience enough "friction" through its interaction with planetary material that simply dropping it inside Jupiter would result in it coming to rest neatly in the planet's core. I'm sorry to disappoint you, but the hole would see Jupiter as being almost as nebulous as a mist on Mars! Sure, it would be gravitationally perturbed by Jupiter, but would sail right through and out the other side with very little loss of energy. What friction that would be experienced would be in the form of gravitational scattering—the transfer of the hole's kinetic energy to stirred and turbulent Jovian material left in its wake. The equation for this energy loss process shows that a hole of 6×10^{20} kg would have to pass through several hundred thousand Jupiters before being appreciably retarded!

There is, however, a way around this problem. Repeated interactions with Jupiter might be obtained by steering the hole into a close elliptical orbit that was partially inside the planet. The hole's orbit would then decay quite rapidly over a timescale of a century or so, until its path was entirely enclosed.

So, we've established that seeding Jupiter with a primordial black hole would be no small task. But in comparison to the *2010* solution, it looks almost mundane. A future technological civilization capable of moving asteroids could probably move primordial black holes of asteroidal mass. The next question we must ask, therefore, is would the black hole method of stellifying Jupiter produce a pseudo-star stable and long-lived enough to permit the terraforming and habitation of the Galilean satellites?

The Long-Term Evolution of Star-Jupiter

The answer to this question hinges crucially on one parameter governing the accretion process—namely the efficiency of conversion of rest-mass energy to *escaping* radiation. Note that I have emphasized the word *escaping*, for the reason that matter being accreted from within a planet might be sufficiently dense to sweep up much of the radiation given off by accretion, causing it in turn to be swallowed by the hole. Thus, the efficiency might fall so low that radiation does not significantly regulate the inflow, which would then occur at the maximum theoretical (hydrodynamical) rate. This would mean that Jupiter would not last very long — maybe a few years—before complete accretion by the hole. Since hydrodynamical accretion depends on the square

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of the mass of the hole, the final moments of this process would be extemely spectacular, as the "bottom drops out" of Jupiter and its surface layers find themselves in free fall towards the center, like the floors of a collapsing tower block!

This is one extreme. The other is that the efficiency remains high, with values similar to those of accretion discs around black holes of stellar mass. This maintains a regulated, exponential, growth of the hole at the Eddington limit. Most people associate the term "exponential growth" with a very rapid runaway process—and it is, terminally, where the growth curve approaches a vertical asymptote. However, initially the growth of the hole would be very gradual, supporting a proportionate increase in luminosity. Now we are talking time scales of hundreds to thousands of millions of years before Jupiter vanishes—a more attractive prospect, I'm sure you will agree!

I outline these extremes to emphasize the fact that no detailed modelling of accretion onto low mass black holes within planetary interiors has been done. The process is still shrouded in mystery and it would be true to say that the value of many parameters is as much a matter of choice as of well-understood astrophysics! However, when speculating on such matters, a choice must be made. Let us take a value, for efficiency, of 10%: according to my calculations, the hole would then grow by a factor of **e** (the base of natural logarithms) every 48.5 million years. In light of this, let us look at a scenario for the possible long-term evolution of Star-Jupiter.

So, we have as a starting point a black hole of 10^{-4} Earth masses, located by a future Solar System civilization and maneuvered in such a way that it merges with Jupiter. As I have already said, the hole would probably be orbiting initially half inside and half outside the planet, with quite dangerous consequences for anybody in the vicinity. Enormous flares would erupt as the hole rises from Jupiter's surface and is no longer surrounded by sufficient gas to absorb gamma rays produced by the accretion process. After about a century, however, the hole's orbit would have decayed sufficiently for it to be permanently lost from view. The newborn pseudo-star would eventually reach a blackbody temperature of over 1,000° K, glowing dull red in skies throughout the Solar System and appearing visually from the Earth about twice as bright as the full Moon. Jupiter-facing hemispheres of Europa and Ganymede would reach temperatures similar to those of the Earth and Mars respectively. Atmospheres of water vapor and other gases such as carbon dioxide would rapidly grow, subliming from surface ices. On Europa, a Jupiter-facing ocean would form, as the surface of the satellite melted. In addition, our future stellar engineers might find Jupiter's magnetic field starting to falter and wane as the ceaslessly plunging hole heats and disrupts the planet's innards. The radiation belts trapped in the Jovian magnetosphere would discharge, liberating the Galilean satellites from their bath of deadly charged particles. Europa, Gan-

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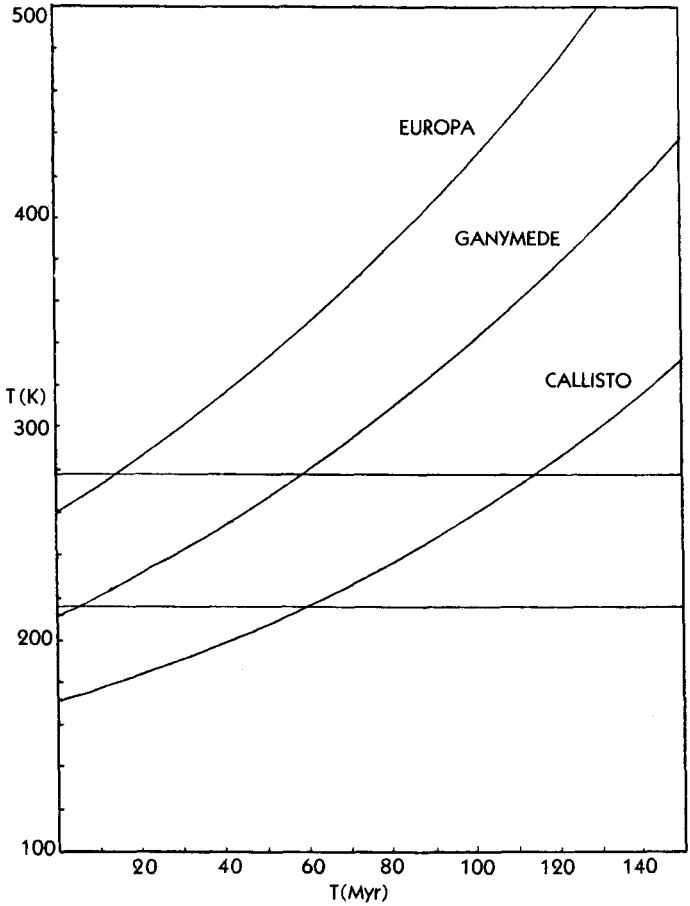
ymede, and Callisto, their surfaces warmed by a brand new category of astrophysical object, would be ready for terraforming.

Figure 1 shows my calculations for the blackbody temperatures of Europa, Ganymede, and Callisto for the first 150 million years after stellification. The two vertical lines enclose a "zone of habitable potential" (ZHP) at which relatively "simple" terraforming techniques might be able to create as near terrestrial conditions as possible. The positions of these lines are somewhat arbitrary—the lower one is equivalent to the blackbody temperature of Mars

Figure 1: Black body Temperatures of Europa, Ganymede, and Callisto after Stellification of Jupiter.



Courtesy of the *Journal of the British Interplanetary Society.*

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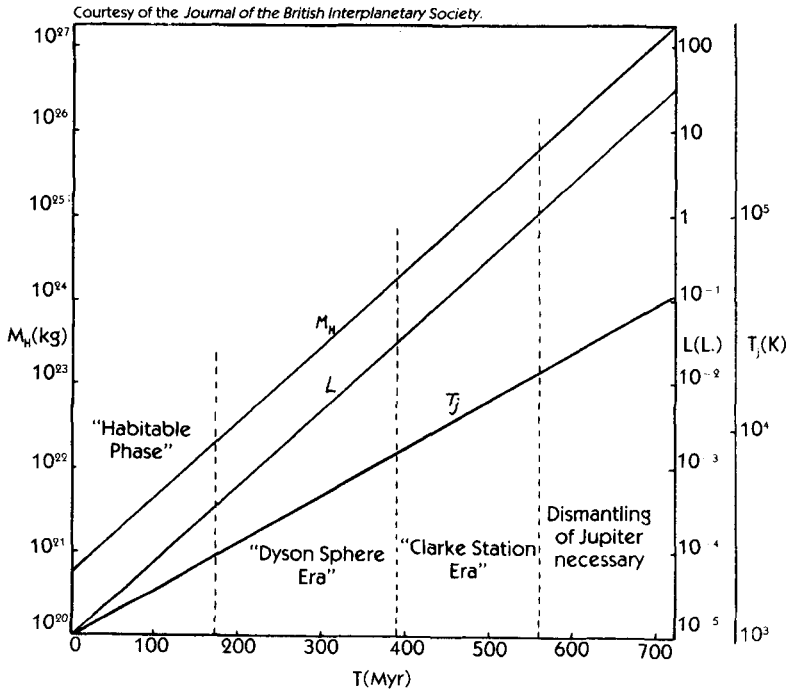

Figure 2: Long-term Evolution of Stellified Jupiter.

and the upper is equivalent to the blackbody temperature of the Earth at 1.4 times its present insolation. It can be seen that Europa is "habitable" for well over ten million years and Ganymede for about 60 million years. Callisto joins the ZHP about the time Ganymede is leaving it and remains "habitable" up to 110 million years after stellification. After this time the Galilean satellite zone would have to be abandoned. The moons themselves might be saved by artifically expanding their orbits, otherwise they might be dismantled for their useful mass or left to quietly boil into space.

Figure 2 shows the long-term evolution of Star-Jupiter, in terms of the mass of the hole, its luminosity (in Solar units) and the temperature of the Jovian surface. It is important to stress that the predicted values for these parameters become increasingly uncertain towards the left of the diagram. The curve for temperature, especially, is for illustration only, as it unrealistically assumes that Jupiter maintains a constant radius. It can be seen that a long intermediate phase would be at hand during which the habitable zone would gradually progress through the outer regions of the Jovian satellite system. This might be

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a time when Jupiter is surrounded by a cloud of space habitats constructed from its small outer satellites—a miniature Dyson sphere, capable of slowly expanding its radius and hosting a population of billions.

By about 390 million years after stellification, Jupiter would be 3% as luminous as the Sun. The entire Jovian satellite system, to the outmost moon Sinope, would be too hot for comfort. However, the pseudo-star would not cease to be of use. Jupiter might be used as an enormous powerhouse for a remote future civilization. The Dyson sphere might be replaced by a cloud of "Clarke Stations"—large light traps designed to intercept sunlight and to convert this energy into microwave beams that could be transmitted to any location in the Solar System.

Eventually however, the luminosity of Jupiter would climb to dangerous levels. *Figure 2* shows that the mass and luminosity of the hole would grow by a factor of ten every 110 million years, until about 720 million years after stellification the final remnants of Jupiter are swept up in a blaze of glory 29 times as bright as the Sun! This assumes of course that Jupiter loses no mass via a red giant-like stellar wind during the final, most luminous, stages of its evolution. This point, though, is academic, because something would have to be done long before, whilst Jupiter is no more luminous than the Sun, to prevent it from toasting the Solar System! The pseudo-star would have to be taken apart to starve the hole of any further mass. If we take the maximum luminosity allowed to be one solar unit, then this is reached when the hole is about 3% the mass of Jupiter, 560 million years after stellification. David Criswell, a consultant to the California Space Institute, has outlined a number of possible methods for dismantling stars, a process that he terms "Star Lifting." I'm not going to review his ideas here (see the reference list); suffice it to say that since he envisages the star lifting process being powered by the luminous energy of the star, and since we choose to "lift" Jupiter when it is as luminous as the Sun (but still of course only a thousandth as massive), then any of Criswell's alternatives might work very well, serving to remove the excess Jovian mass in about a million years. With 97% of Jupiter's mass unaccreted, a new giant planet might be assembled, perhaps around another primordial black hole.

Thus, half a billion years into the future, all that might remain of Jupiter in its original position would be a ten Earth mass black hole. Need this be the end of the story, however? No! The hole could still be used as an excellent power source by allowing matter to accrete onto it in a controlled way. Furthermore, if nucleosynthesis (nuclear reactions between light nuclei to form heavier ones) can occur in hot accretion discs around black holes, as has been recently suggested, then a future civilization might use the post-Jovian black hole as a gigantic alchemist's crucible, mining the hole's outflow for synthesized heavy elements.

What then? We could try to look even

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further into the future, but no, let's leave it at that. Perhaps half a billion years' worth of speculation is enough for one article!

Conclusion

The scenario that I have outlined for stellifying Jupiter is certainly more feasible, from the astrophysical point of view, than Arthur C. Clarke's spectacular implosion at the end of *2010*. It depends on three principal assumptions: 1) primordial black holes of the right mass are abundant; 2) a technologically advanced civilization comes into existence throughout the future Solar System and 3) the efficiency of conversion of rest-mass energy to radiation for black hole accretion from a dense medium is about 10%. All three of these assumptions are reasonable given the uncertainty in each case.

Assumption #2 is the only one I haven't touched on, for it deals with future history—something well covered in the fiction pages of *Analog*. It is obvious, however, that any civilization considering stellifying Jupiter must be capable of handling projects of vast scale over long periods of time. It would have to possess a sort of "Stapledonian" transcendance. Perhaps it is therefore appropriate to end this article with a quotation from Olaf Stapledon's *Star Maker*.

"It must be remembered that a fully awakened world had no need to think in such short periods as a human lifetime. Though its individuals might die, the minded world was in a very important sense immortal. It was accustomed to lay its plans to cover periods of many million years." ■

Grammatical Note

Vernor Vinge in *Marooned in Realtime* used the word "stellate" to describe the turning of Jupiter into an artificial star. According to the *Shorter Oxford Dictionary*, "stellate" is defined as, "Of the sky: studded with stars. . . ."

In this article, I have used instead the word "stellify" which is defined as, "To transform into a star or constellation. . . ."

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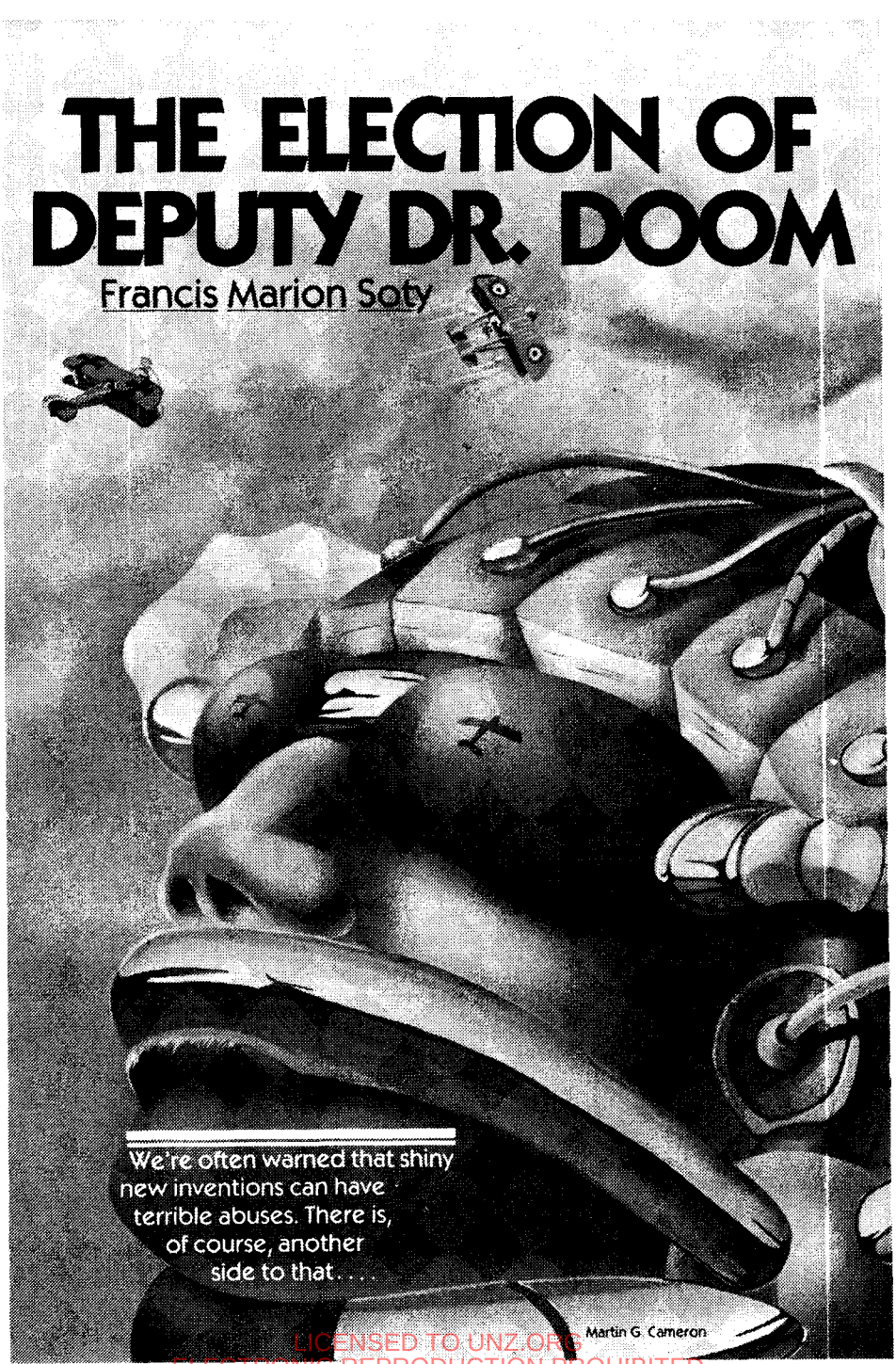
THE ELECTION OF DEPUTY DR. DOOM

Francis Marion Soty


We're often warned that shiny new inventions can have terrible abuses. There is, of course, another side to that. . . .
Martin G. Cameron

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"Aaah, Kelvin . . ." One of the two imprint doctors, Pullyou and Pushyou to the students of International Medschool, had seen Kelvin Bryant's unguarded look of apprehension. Too late, he straightened his shoulders and gave them a big smile. "You're halfway through imprinting. You know this doesn't hurt," Pushyou went on. He was a plump, apple-cheeked old man, with red-veined eyes and an almost vertical shock of white hair. His real name was Ed Jakobs, and he was a heart specialist.

"And the new headache jet is so good some students say they only feel a twinge or two," added Pullyou, a short, attractive young brunette named Athena Theodopolous. She was an associate professor of gynecology, and the object of Kelvin's frustrated desire.

"Hi, Ed. Hello, Athena." Kelvin gingerly seated himself in the imprint chair, familiarly known as "Ol' Sparky." He wished he could have thought of something bright and clever to say, and that his voice was deeper. He tried to repress the usual feeling of panic when the padded restraints emerged smoothly from back and bottom. Three of the arms adjusted themselves to his lean body, while the fourth slid across his face beneath the nose and locked his head firmly in place.

"Are you going to the Deputy Dr. Doom election rally at five o'clock?" Athena asked, as she gently lowered the heavy plastic helmet. "Who do you think is going to win?"

"Probably the big man on campus this year, that Nigerian President's son, Ajana Akitoye." No matter how many imprints he received, Kelvin could never repress a feeling of horror as the cap slowly *crawled* over his scalp, seeking its exact position. "And no, I'm not going; too boring."

Kelvin tried to ignore the cap by thinking of something clever to say to Athena. But both doctors had turned away and were busily taking their measurements, setting up for the run.

"Why did you go for brain surgeon anyway, Kelvin?" asked Ed over his shoulder at the main console. "You know there's a serious oversupply situation. You'll never get your own practice."

Kelvin moved his eyes enough to sneak a look at Athena, who was sitting with her profile to him at the adjacent console. She wore a lab smock that fitted tightly over a large bosom, and stopped at mid-thigh to display beautifully curved, muscular legs. Athena turned her head and gave him a quick smile. She was also his counselor, and Kelvin was convinced he would love her until he died. She had sweetly ignored his fumbling attempts to gain an invitation to her campus apartment.

"Ed's right, Kelvin," said Athena. "Your recent psych profile reinforces what I already knew, that you're a very nice person, but low on dominance. Your reflexes are just barely adequate, and hand-skills are one quality we can't imprint into you. Won't you reconsider my suggestion that you go for internal medicine?"

Pushyou, Pullyou . . . Kelvin wavered, doubting. Many a career had changed here, before the current flowed. It was too late, once this imprint was in. The school allowed no changes in the second and final year. Brain capacity

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was finite, erasures too difficult and uncertain.

"I know you have my best interests in mind, Athena . . . " he hesitated, not wanting to reveal that he had chosen to be a brain surgeon while watching reruns of "Dr. Adair" as a child. "I don't have to be a chief scalpel to be happy. Just knowing I'm part of a team that helps people, that's enough. Please go ahead."

"Okaaay, Kelvin. If you insist . . . " Athena turned back to her controls. He felt the first surge of prickly heat penetrating straight through his skull, and then the welcome tide of darkness rolled in and he flew toward it, plunging deep, deep . . .

"OK, Kelvin—out of the chair. Next one's waiting."

Electric arc lights, bright, a concealed glowing . . . walls hospital-white, clean, shiny . . . looking back at Ol' Sparky, waiting with computer patience for its next victim. Head pounding . . . the king of all headaches, oh Howlin' Hippocrates, so awful . . .

Ed helped him to one of the monitoring couches in the outer room. He walked through fields of receding blackness, flashes of light blooming and crackling like fireworks when he closed his eyes. Confused, numb, he collapsed and lay back, head on the springy pillow . . . why was he here? . . . Oh yes, the diagnostic imprint, first of the year . . . Stupid . . . Odoroso Cleanman Pendergast had more important things to do. Must be up and off to the five o'clock rally . . .

He faded in and out for a minute, and then the world solidified, took on form and substance. He took several deep breaths, and sat up. The couch immediately said, "You are not ready to walk yet, Student Kelvin Bryant. Please return to the horizontal position."

Kelvin Bryant? What the hell was this? Odoroso ignored the stupid, mistaken machine, and got to his feet. He staggered a little, but felt better once he was out the lab door and into the bright sunlight of Los Angeles.

Odoroso glanced at his all-purpose. Only eleven, and the rally wasn't till . . . five? Why was he in such a hurry, then? Plenty of time to talk up the cause, make a few converts. . . . He walked onto the rolling easyway and headed for the Student Center, forcing the fading headache into the background. . . . On top of the world now, confident he could persuade, cajole, convince the doubting. Ajana Akitoye was the only possible choice for Deputy Dr. Doom. By far the best candidate . . . the others were all administration lackeys, picked peppers, hot because they were flavored . . . favored? No matter. He shook his head, trying to clear away persistent cobwebs. Had to get busy . . .

Odoroso walked off the easyway at the two-story Student Center, pressed the black handglass face for ID admittance, and entered. He saw no one he knew, but nevertheless went up to two couples chatting at a small dispenser table and pulled up another relaxor.

"Hi, I'm Ordoroso Cleanman Pendergast." The four students turned and stared at him, a little startled. "I'm assistant campaign manager for Ajana Akitoye. He's running for Deputy Dr. Doom, you know. Do any of you know

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Ajana? No? Well, I want to help you understand that there's no one in the running who knows more about computers, or will be willing to work as hard. Ajana is a Nigerian, and they have a cultural tradition that demands they work all the time. What better choice for a dog-dog job like Deputy Dr. Doom?''

One of the girls leaned forward, bare arms on the table. A pretty copperhair, she was wearing a loose transparent blouse with diffraction panels in front of each breast. Odoroso tried to maintain eye contact, rather than letting his gaze shift to the flickering, moving, splintered images beneath the cloth. Women had no right to attempt to distract a man from his duty! Some inner voice seemed to be desperately crying *Look! Look!*—but he overcame it, and succeeded in ignoring the distraction.

''Why do we have to hold an election, anyway?'' the girl demanded. ''I wouldn't have that job as a gift-pepper! This is my first year, but as I understand it, 'Deputy Dr. Doom' is in charge of drafting students for unpaid work. They have to research all of last year's medical literature for additions to the International Physicians Database.''

''We were told that the work is compulsory if you're picked, but there's no credit for it, except for Deputy Dr. Doom,'' added the male student sitting by her. ''Everyone that he drafts hates the Deputy. Who has the time for extra work?''

''And what idiot named the largest and finest medical database in the world 'Dr. Doom,' anyway?'' demanded the second female student.

''Anyone who really wants that job has to be crazy,'' said the first young woman, with a deliberate toss of the long coppery hair. The upper body motion caused the diffraction panels in the blouse to sparkle in several colors.

Odoroso suppressed an impulse to tell this first-year female what an idiot she was, and a second one to ask if she would like to go upstairs to one of the privacy rooms for sexual recreation. Why was he letting his mind stray from the important work he had to do? Instead, he gave the girl a reasoned argument why Ajana was a far better choice than any of his competitors. She listened intently, and he felt, finally, that he had convinced her. The other three seemed to be paying close attention. Odoroso became confident that he had won over at least two of them also.

There were various couples, foursomes, and some larger groups at a few of the tables, and a milling throng of people visible through the glass doors that opened onto the covered Olympic-size pool. Odoroso saw several other students talking animatedly to anyone who would listen, some waving their arms almost hysterically. Probably more campaign workers. If they were not for Ajana, they were wasting their time.

He picked out another likely looking foursome, and moved in on them . . . confident, capable, persuasive, computer-smooth . . . a born campaign manager. Why was he only a deputy, anyway? Who was . . . but the thought faded, and he forgot it . . . important work to do.

Sometime in the afternoon hunger pangs reminded Odoroso that he had forgotten lunch. He ate a straight protein bar quickly, downing it with hypermilk,

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and went back to work. He had passed close enough to other campaign workers in the Student Center to hear most of their pitches, and all of the ten or more males there were loudly and vehemently for Ajana. Strangely, he realized, the two females quietly soliciting votes were against him. But they were also divided between two other candidates, which could only help Ajana. The top vote-getter won, regardless of percentages.

The five o'clock election rally was in front of the Cirque Theater holostage in Peace Park. When he understood that a sizable percentage of the students still in the building had no intention of going, Odoroso cajoled, pleaded, and finally sternly lectured those within hearing range as to their responsibilities. It was all in vain. That final effort made him so late he had to almost run to make the rally on time.

The selection of Deputy Dr. Doom was one of the early fun events of the year, made more so by the fact an election could not be refused. Usually, as with Ajana and his competitors, someone actually wanted the job. But it was not uncommon for a group of friends to select someone they disliked, and campaign hard to get that person elected. There was little the unwilling winner could do in retaliation, except draft all the second-year student plotters who could be identified. But a draftee could only be forced to input so many megabytes of data, and then the obligation was completed.

There was a crowd of several thousand in Peace Park. The daylight entertainment this afternoon was a tenth-size duel between a World War I German Halberstadt and a British de Havilland 2. The stage was large, but the planes required a great deal of room. Sometimes one moved so quickly that the computer generating their maneuvers could not turn it in time without an unacceptable strain on the wings. It then vanished, and returned by appearing over the holostage from another entry point. That was poor programming. But Odoroso had to admit that the screaming engines, chattering machine guns, and streaks of fire from the nozzles made a satisfying display of sound and fury.

The de Havilland went down in flames just before five o'clock, to Odoroso's satisfaction, and the air cleared above the stage. The candidates had each prepared a final five-minute holo, which was now shown about twice life-size. The first contender was a young woman Odoroso did not know, a tall, slim Scandinavian blonde, who wanted the job because she liked to work with databases. Then Ajana popped up, wearing a Yoruba robe and a broad smile. He was an impressive figure, tall, muscular but trim, with teeth that seemed to shine with extra whiteness in the slanting light of late afternoon. He had a strong, deep voice, stood straight, and delivered his lines with regal dignity.

Ajana explained, briefly, that he wanted the job because he intended to devote his life to developing automated surgical units. In the Federation of Northwest Africa, which his father headed as Elected Administrator, there were still many villages and some fair-sized towns without a doctor. Since no licensed practitioners wanted to live there, people with medical problems had to travel long distances, or rely on

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automated diagnostic and dispensing machines. These worked well enough for internal medicine, but had no surgical capability.

Ajana made a good case, but so did his final opponent. She was a young Oriental woman who was interested in medical data analysis, and wanted to devote her entire career to working with Dr. Doom. She believed that now was the time to start. Her presentation was straightforward, sincere, and appealing. Ajana, by contrast, seemed an aloof and somewhat forbidding figure—too majestic by far to be democratically likable.

Odoroso glanced around unhappily, to see how the voters seemed to be accepting the third speaker. He saw that the students present, about a quarter of the 20,000 at International Med, were forming voting lines. A hologram of each candidate, selected from his or her presentation, stood tall and still, staring out over the crowd from near the edge of the stage. Nine portable handscreens had been installed at ground level, three in front of each image.

Many students had already voted on their room Comsets, but there were always a few thousand people either late or unable to decide. These were now hurrying past the handscreens, with a quick slap on the black glass. Odoroso noted, with dismay, that the lines in front of the Oriental girl's three sets seemed to be slightly longer than those in front of Ajana's.

"Are you going to vote for me, Kelvin?" asked a deep, pleasant voice at his elbow. Odoroso jumped as if thumbed in the ribs. He turned to see Ajana Alafix Akitoye smiling down at him.

"Of course I'm going to vote for you!" Odoroso said, letting smouldering anger show in his voice. "I'm your deputy campaign manager, aren't I? I've been working hard for you all day! And why do you call me Kelvin? Today everyone thinks I'm a temperature scale!"

"Oh, ah, of course. Please excuse me." Ajana bowed slightly. His usual entourage of about five giggling female and two other tall black African male students stood close behind him. "Your name is Pendergast, yes? Odoroso Cleanman Pendergast; I remember now. Did you by chance have the cap on today? You did? Stimulating experience, what. Did you remember to vote yourself?"

In a rush of confusion, Odoroso suddenly realized that he had been too busy campaigning to get back to his room and vote. He hurried forward, tried to cut into one of the lines in front of an Ajana screen, and growled at the aggressive young black girl who demanded he go to the rear.

Walking in the moving line, Odoroso swiftly grew bored. There was something wrong with his head today. It was normal to suffer some sense of disorientation after an imprint, during the hours new knowledge was being integrated with the old, but he had a really severe case of it this time. He seemed to be separating from his body, rising above the noisy, laughing crowd of mostly young people, to float in the air . . . climbing, turning, reaching ever higher . . . like that triumphant German Halberstadt as it rose on screaming eagle wings . . . and then he was in front of the handglass; he had been in

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line almost no time at all, and he slapped the black face on the trot as he hurried by.

There seemed to be more than the usual post-print confusion in Odoroso's mind. He was not thinking clearly, unable to focus on any subject except the election. Next time he would spend the rest of an imprint day in his room, as most students did. . . . He stood and waited as the last of the lines went past the machines in the Oriental girl's group.

Student body president Anwad Hadadd had been standing and talking with Ajana. He palmed the nearest machine after the last voter passed, and asked for the results. The printer beneath the glass chattered briefly, and spat out a small sheet of paper. Anwad pulled it free and quickly read the figures. No microphone had been supplied, but he climbed on the stage, faced the waiting crowd, and shouted as loud as he could: "THE FINAL TALLY IS! ASTROGATE HARDINSON, 2,402! UMIKI MIYOSHA, 4,641! AJANA AKITOYE, 4,742! THE WINNER AND DEPUTY DR. DOOM FOR 2031 IS—"

With no warning at all, the air around Odoroso suddenly seemed to be quivering and shaking, as though an earthquake had struck. There was a sharp, splitting pain in his head. Dimly, as if from far away, he heard "—AJANA AKITOYE!" Anwad called for three cheers for the winner, but the noise, when it came, sounded in his ears like surf breaking on a gentle beach. Odoroso opened his mouth to join in, but suddenly became dizzy, almost unable to stand. His headache came thundering back, worst than at its beginning. Then there was an almost palpable sense of relief as the presence of Odoroso Cleanman Pendergast slid out of his brain, and he became Kelvin Bryant again.

Kelvin stood where he was, rigid, his eyes blinking rapidly, trying to get his mental bearings. He had a sudden thought, and looked quickly around. Most of the laughing, chattering crowd had headed for the park exits—but here and there some individuals, all males, seemed to be standing still, bewildered, as though suddenly lost in an unfamiliar desert.

Kelvin spotted the tall form of Ajana and rushed at him, trying to push through the admiring circle of sycophants and well-wishers who were crowding around the new Deputy Dr. Doom. He managed to force his way inward by almost violently shoving people, until he could look up into Ajana's face. "*You!* . . ." he had to pause for breath. "You! . . . You planted a virus persona in the imprint machine! You took over my mind!"

Ajana stared at him, eyebrows raised in polite inquiry. Around them Kelvin saw several other students, some of whom he recognized as fellow second-year men, pushing toward them. He also saw slight, knowing grins on the faces of Ajana's two countrymen.

"All that work I did for you! I don't even *like* you! You're a conceited, arrogant . . . how *dare* you mess with my mind!"

Ajana raised a chiding finger. "Careful what you say, Kelvin. Persona imprints are an experimental technology, and not approved at present. Accusing me of having one placed in your head is a serious charge. Unless you're pre-

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pared to prove it, I think my attorney would consider such statements actionable. Didn't you take your lawsuit imprints in first year?''

The several other men who had pushed their way through the crowd had all arrived in time to hear Ajana. He looked out over their heads with his usual broad smile. ''May I suggest we adjourn to the Student Center, where I think my credit will be good for stimdrinks all around? All who voted for me are welcome, and in particular, my campaign manager—'' he nodded at one of the tall black Yorubans who was a constant companion''—and all of the many deputies who contributed so much time and effort to our cause. We've won—and now it's time to party!''

Ajana turned and led the way. The crowd followed, still laughing and chattering with excitement. Kelvin stared after them with bleak anger. The hidden virus Ajana had somehow sneaked into the computer had ordered the imprinting of a complete persona to overlap his own, obviously without the knowledge of the operators. The program must have activated itself first thing this morning, so that every male who received an imprint today—and there would have been many, since this was a busy time for the eight campus machines—became Odoroso Cleanman Pendergast.

How Ajana had gotten into the main machine, and how he had created such a functional persona . . . The more Kelvin thought about it, the more a reluctant admiration began to color his anger. Since the vote was close, it was very likely the work of all those dedicated Odorosos that had made the difference. Ajana was well known on campus, but not that well liked. He was always courteous, and thoughtful to an extreme. But his father was too rich and important, and Ajana too conceited, arrogant, and self-assured, for him to ever become popular.

Kelvin started slowly walking away from the holostage, his mind still whirling with thought. Ajana seemed sincere. And very likely the breakthrough he had apparently made in persona transfer could be applied to the existing medical diagnostic machines. If so, it could also be used to personalize the new surgical ones the Nigerian planned to design. He was almost certainly a better computer program designer than his opponents. Actually, the right person had won the election.

As Kelvin left the park, he saw a familiar figure approaching on the easyway. He walked out carefully, timing it to end up beside Athena Theodopolous. The muscular but shapely calves Kelvin so admired showed beneath a knee-length bouffant light-skirt that shone with blue fires in the gathering twilight. A matching half-blouse with deep cleavage, that still left the midriff bare, showed most of her fine bosom to advantage.

Athena smiled brightly when she saw Kelvin maneuvering to reach her. He really was a very nice young man. And not bad looking, under the scruffy student clothes. She had ended a rocky relationship with an older and newly divorced teacher three days ago, and was felling a strong need for male companionship. If only Kelvin could be a little more forceful. . . .

''Er . . . hello!'' Kelvin said as he reached Athena.

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"Hello, Kelvin. Are you going to the post-election party?"

"Uh . . . Yes, I think so. You can't get in there, can you?"

"No, it would be breaking that dumb rule that forbids teachers in the Student Center after six. It means I have to spend a quiet evening at home."

The smile on her full lips seemed almost like an invitation. There was an air of quiet waiting about her as she stood looking up into his face. Kelvin suddenly understood that his chance had come at last. He had only to reach out and grasp . . .

The thought froze Kelvin's tongue. He stood there, helpless, as the Student Center approached . . . he opened his mouth, but could only gape soundlessly, and closed it again.

Memories of the recent hours he had spent as Odoroso Cleanman Pendergast came flooding into Kelvin's mind. He remembered the smooth, confident, aggressive style of the persona, the self-assurance, the single-minded dedication to a cause . . . a strength of personality he had never possessed, nor ever would. As he stood mute, tongue-tied, Kelvin longed, with desperate and unashamed ardor, to become once again the person he had been for a single afternoon . . . *Odoroso! Odoroso!*

While Kelvin waged his inner battle, he saw the smile on Athena's lips slowly fading. There was a perceptible change in her attitude and body posture, as though she thought he was deliberately rebuffing her overture. He realized that even if he could speak now, magically summon the right words, it was already too late. His chance had come, within the span of a few fleeting seconds—and left even faster.

"I—I'll see you!" Kelvin said, too loudly, and went plunging for the edge of the easyway at the exit to the Student Center. "Have a good evening!"

Kelvin stopped just off the easyway, shaking with tension. He watched Athena until she vanished around a tree-lined turn. She did not look back.

Breathing heavily, Kelvin walked slowly toward the entrance. He had a stimdrink coming . . . and he needed to really congratulate Ajana on his victory . . . Sincerely so, because he meant it. Above all, he wanted to know more about the persona imprint program, and how close it was to being ready. He could see a bright future ahead for the friends of Ajana Akitoye . . . ■

●Experiment and theory often show remarkable agreement when performed in the same laboratory.

Daniel Bershader

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futures

Matthew J. Costello

The first time I called William Gibson to ask him about his script for *Aliens III*, he was able to say nothing. Nada. Hollywood can be incredibly protective of its projects, struggling mightily to control the flow of information to the media.

There was, of course, a lot of interest in the *Aliens III* project. The first film, directed by Ridley Scott, featured the biomechanic horrors designed—for the most part—by the Swiss artist H.R. Giger. In the film both the world of the aliens and the Earth ship, Nostromo, reflected back on each other, intensifying the claustrophobic terror.

While *Alien* was a souped-up Fifties shocker, *Aliens*, directed by James Cameron of *The Terminator*, was, as one of the characters comments in the film, a "bug hunt." It lacked the horrific shocks of *Alien*, but it was a relentless, gritty film of first contact and fire fights with some durable opponents with acid in their blood. The aliens became less imposing under the firepower of the space marines . . . but now there was an army of them.

Aliens III, with a script by William Gibson, author of *Neuromancer* and *Mona Lisa Overdrive*, was to develop the mythos even further. Even when he wasn't free to speak, Bill Gibson admitted that we would see more of the aliens' milieu.

By the time I checked back with Gibson, his script was completed, turned in . . . and he was off the project. He didn't seem overly upset about having suffered that rather-normal Hollywood fate of musical scriptwriters. "It was like an 'earn while you learn' situation," he said of his first script. "And it was a cold start. I never aspired to it [scripting] though no one believed me."

Despite his equanimity over his script's rejection, I couldn't hide my disappointment. Gibson's involvement had made interest run unusually high, and I wondered whether any of his ideas were likely to make it into the new script.

"I have no way of knowing," he said. "The writer's the last person to know." But he also mentioned that it was unlikely that the world surrounding the aliens—their home planet, their life cycle, their grisly place in the universe—would be explored too much. The cost of widening the focus a great deal would be too prohibitive.

Happily, Gibson has picked up other scripting chores due to *Aliens III*. "Because I was doing that one, and it was a high profile project, I was hired to do more." This, he suggests, is due to Hollywood's herd instinct. He's currently writing screenplays based on his own short stories.

I also ask Gibson how he likes the recent computer game licensed from his book, *Neuromancer* (Interplay, 1575 Corporate Drive, Costa Mesa, CA 92626). He chuckles. "I've never played a computer game in my life." He said

(continued on page 176)

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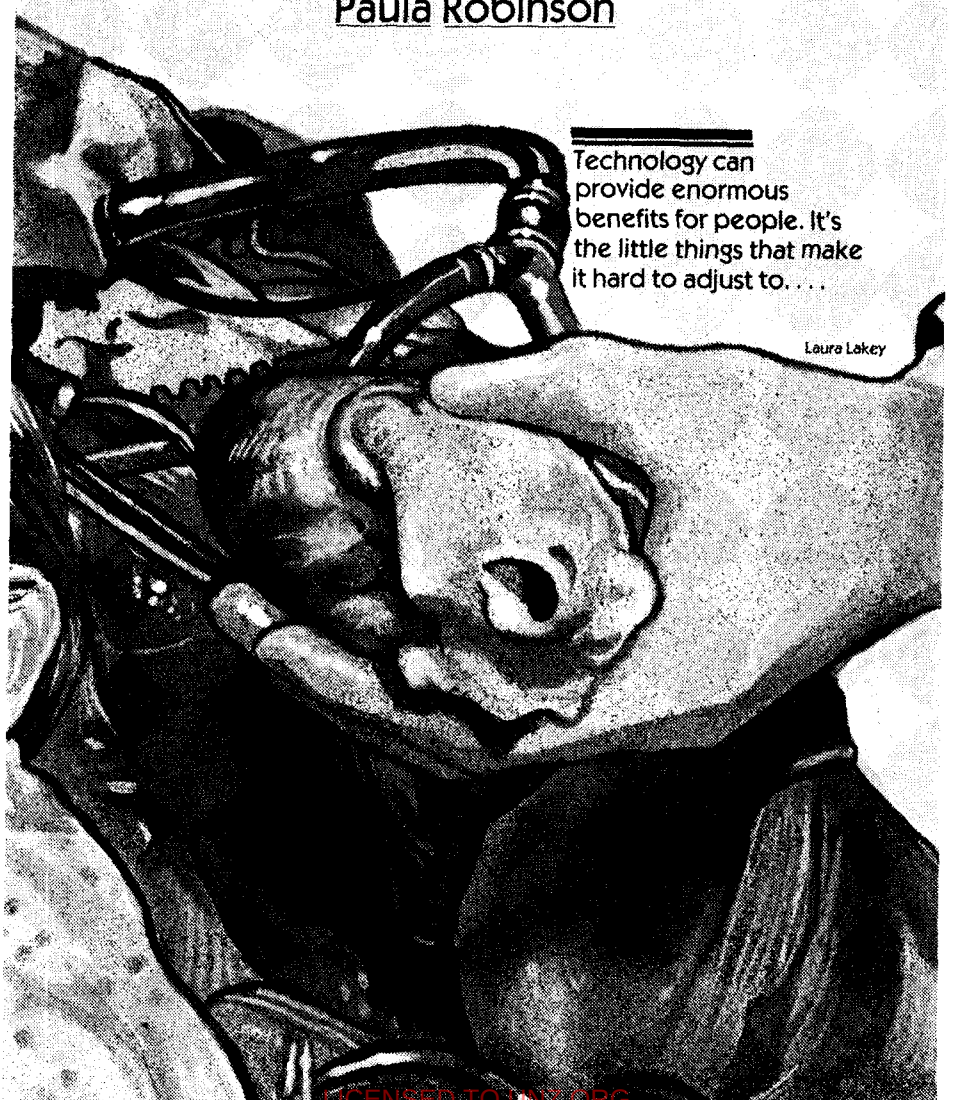
HEARTS AND DANDELIONS

Paula Robinson



Technology can provide enormous benefits for people. It's the little things that make it hard to adjust to. . . .

Laura Lakey

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The tube leading into Abe Lyman's left side jiggled as the blonde technician removed the pneumatic drive from its carrying case. The air compressor powering the artificial heart sounded louder than usual without its noise insulation.

Sweat beaded on his face, draining into his dark hair and beard.

Thump, hsst, thump. Hsst!

He fought memories of his last installation surgery. It had been done in this hospital. That was when this heart went in to replace the one he'd had for his late childhood and teen years.

"So, do you have family around here?" the technician asked, obviously wanting to distract him from the procedure.

"Used to."

"They moved?"

"No. My father died when I was seventeen. Mom passed on last year. Heart attack. Both."

"I'm sorry . . ."

Abe stared at the ceiling, the only thing he could see well from his place on the examining table. "It happens."

"Wasn't there any warning? They could have gotten artificial hearts like—"

"No, there wasn't any warning. It was just a fluke. Sometimes things happen that way."

She sighed, concentrating on the machinery. "Yes, I know. But it's good that you were able to get the heart before something like that happened to you." She tried to smile as she met his glance.

"Sure."

They paused. She removed small panels from sections of the pneumatic drive, checked machinery, and made adjustments.

Abe dreaded her next statement.

"We're going to stop your heart now, Mr. Lyman. It'll only be off for about twenty seconds. You know—"

"Remain calm. Shallow breaths. I know."

"I can see you've been through this a few times. I'm sorry to have to do it, but you know it's necessary."

The wrenching Silence began. Abe swallowed terror as his pulse stopped. His blood turned gelatinous as his vision clouded with unnatural light—the result of collapsing vessels in his retinas.

Just as suddenly, he heard the technician snap in the replacement air-compression module. His veins throbbed with life again.

Thump, hsst, thump. Hsst! Thump, hsst, thump.

His vision cleared. Flecks of light still danced in the periphery as he looked at the woman who had stopped his heart.

"I tried to make it quick. You did very well, Mr. Lyman."

Abe blinked a few times, stared, sat up. "Thank you."

The first of the surgeries came when he was seven, when his natural heart was replaced with a pediatric Jarvik-Smith model. The portable drive units for artificial hearts hadn't been perfected then. For two years he'd lived in a hospital bed, or very close to one, attached to one of the old, nonportable drives.

The second surgery came when he was fourteen, replacing the pediatric Jarvik-Smith with an adult model. Abe regained some mobility then with the portable external pneumatic drive, or PEPD as the experts called it. The third heart went in when he was eighteen.

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That was the least traumatic surgery for Abe, since the newest heart used the same PEPD as the second.

Seventeen years ago he'd named the PEPD Lub Dub. One of the many cardiac nurses in his memory had suggested the name to him when, at fourteen, he'd experienced post-surgical depression. Lub Dub had been Abe's constant companion since then.

He usually just called the PEPD "Lub" for short. It was "Lubby" when he felt particularly affectionate toward it. Later, as he grew to maturity, he started calling it "Dubshit" when it annoyed him.

Often at night he imagined Lub spoke to him in rhythmical, cadenced words, often about ordinary things. "It's warm—out-side—to-night—you know —" And he'd think, "Shut up, Lub, and drink your juice." It was an ancient joke. He often thought of it during the six hours each night when he had to keep the drive plugged in.

Sometimes he used the joke to put other people at ease: normal people. He'd learned long ago that normal people were distressed by the tubes and noises which, to him, seemed perfectly normal.

Of course Lub didn't shut up—he'd be terrified if it did—but somehow the imaginary conversations made the machine more a pesky roommate than a mechanical aid.

He usually carried the drive rather than clipping it to his belt. Doing so made it easier to manipulate the drive and tubing so it wouldn't be uncomfortable.

Abe perspired in the heat. He hated being hot. Sweat trickled down his arm and made the smooth handle of the PEPD slippery, and that could be dangerous on a busy sidewalk. He looked forward to resting at Mabel's Cafe.

As he approached the restaurant Abe could see that the air conditioner was on. It was an older model, mounted over the door, and as usual it was dripping water onto the sidewalk. The owner kept saying he was going to move it to one of the windows. He'd said that for five years. Abe stepped around the tiny, punctuated waterfall and went inside.

"Hi, Abe."

Roseanne was pouring coffee for one of the customers. She was a big woman, somewhere in the nebulous age range between forty and fifty, and she wore the standard ugly pink waitress uniform.

Abe smiled. "Hi, Roseanne. When's Ray going to move the air conditioner?"

She leaned back, coffeepot still in hand, and raised her eyes. "Huh!"

It was an old, running joke.

"What brings you in this time of day?" Roseanne asked.

"Nothing much. I had a while before I had to meet the group in the park."

"Goofing off, eh?" She gave him a look of false reproach as she whipped out the order pad.

Abe thought of the temporary agency that got him occasional deskwork— typing, form-filling, phone-watching. They hadn't called since he lost a job last week. Somehow he'd gotten regular coffee instead of decaf at the lunch bar, and his heart, sensing the caffeine had sped up so badly that he'd had to go home.

"I got the week off," he answered.

Roseanne shrugged. "What'll it be?

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We have specials on liver and egg salad—''

''Just toast today.''

He'd have to find another agency. His work record was good otherwise. He could last another week or so before the trust pension his parents had supplied would need supplementing.

Roseanne smiled and patted his shoulder. ''Glad to hear you're taking a vacation. Sometimes you look as if you're working too hard.''

Abe huffed. ''Don't we all!''

''*Tell* me about it.'' Roseanne winked and dashed off to get several plates for customers across the cafe.

Abe waited for the WALK signal when he got to the corner. People stared. He hardly noticed.

The PEPD had sensed his exertion, and compensated by speeding up the beats.

Thump, hsst, thump. Hsst! Thump . . .

Roseanne had been busy, so he'd finished the toast and read the funny papers before leaving. It was almost time for the meeting, anyway.

Thump, hsst . . .

Abe's fingers slipped from the moist handle as he stopped to put the unit down. It landed on the sidewalk with a sharp crack. The tube leading into his chest wrenched, making him gasp, but he recovered quickly.

Onlookers stared with concern for a moment. Abe ignored them. He had learned long ago that the artificial heart was tough enough for this sort of problem. The designers had known that tubes would be yanked and drives dropped. If only they'd thought to make the drive handle less slick. He'd have to get a new one, one of these days.

Cars slid to a halt as the light changed. Abe wiped his hand on his shirt and once again lifted the portable drive so he could cross the street to the park.

The PEPD support group met every three weeks. This time they had chosen the park, a patchwork of sprawling fields and woods bordered by city streets.

They sat at a shaded picnic table. Nearby sounds of traffic and children playing muffled the constant thumping and hissing of the drives.

Abe's eyes were on Colleen Mays as he approached the group. All six members, including Abe, were present. Colleen was the newest. There was Mrs. B, actually Thelma Bjorndahl, a thoughtful older woman with endless optimism. Simon York was the young, dark-haired fellow with wire-rimmed glasses. Jason Blair, a middle-aged black man with a sharp yet endearing wit, sat next to Selma Ryers.

Selma, also black, was a striking woman. Slim and tall, she held her place on the bench with a nervous air, like a sparrow about to fly. She timidly held a few dandelion blossoms in her slender fingers.

Pretty, quiet Selma. Abe wondered if Jason had been able to tease her into a date yet. He'd been trying for months. Abe wished him luck. He liked Selma, despite her shyness, and he thought that if anyone could break her out of her capsule, it would be Jason.

Greetings were exchanged over the rhythms of the pumps. Mrs. B offered punch from a cooler while Selma cooked chicken franks. Simon laughed at some-

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thing Jason said. Abe noticed uncomfortably that the latter two were glancing at him and Colleen.

Colleen sat with Mrs. B. She laughed with the rest, but her eyes didn't sparkle the way they should. Abe put a mental asterisk on that fact while he passed her, then deliberately turned his attention to Mrs. B's punch. It wouldn't be wise to be overattentive with Simon and Jason around. Well, not yet, anyway.

"I don't know how to deal with the noise."

The statement had come from Colleen. The meeting had begun after the chicken franks and punch had been devoured.

"I think everybody here has mentioned that problem, dear," Mrs. B assured her. She patted Colleen's arm.

The group was silent for a moment. The children who had been playing in a clearing had disappeared into an old yellow station wagon some time ago. Only wind in the leaves interrupted the steady rhythm of thumps and hisses.

"This group sounds like a drum corps gone crazy," Jason finally commented. The tension broke.

"Crank up the stereo and play Bach full power," Simon suggested. "Or operas with heavy drums."

Mrs. B nodded. "For me, hypnosis works best. I put myself under. You'd be amazed, Colleen. You can really tune out the noise."

"I chop wood," Jason told her. "I get so pissed off at this Siamese twin." He yanked a thumb at the place several inches below and slightly forward from his left arm where the tube went in. "So I exercise until it's working harder than I am." He slapped the PEPD. "Take *that!* —Pretty soon I've got a cord of wood for the fire, and I'm so worn out I don't care about the noise anymore."

"How about you, Selma?" Colleen asked.

Selma twisted the dandelion stems in her hand, getting their sticky milk on her fingers. "I just don't think about it," she muttered vaguely.

"I don't see how you can help it," Colleen told her.

"I just . . ."

"Don't mind Selma," Jason said. "She just never stops running on." He touched Selma's arm. She gently pushed away his hand.

Colleen nodded slowly. "So everyone finds his own solution. I live in an apartment; maybe headphones would help."

"You haven't heard how Abe handles the problem," Simon said. "He's had the old arty-fart longer than any of us."

They all moaned at the pun. "Watch it, watch it," Jason mumbled with false gravity, to draw a saving chuckle.

"How *do* you handle it, Abe?"

"Oh, it's sort of left over from when I was a kid, Colleen."

"He gave it a name," Simon told her.

"Really." She smiled, her brown eyes brightening a little. "What do you call it, Abe?"

Abe hesitated.

"Well, aren't you going to tell her?" Jason asked Simon indignantly.

Simon shrugged. "*Me?* Heavens, no!"

"I call it 'Lub Dub,' " Abe said.

" 'Lub Dub.' I like it." She smiled.

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"Most of the time I just call it 'Lub.' Some nurse suggested making friends with the drive when I was a kid, so we came up with the name. Personified the thing. I even have imaginary conversations with it." Abe laughed nervously.

Colleen laughed. "I can see how you would."

"I'd get lonely when I was a kid sometimes. The other kids—you know how children are. . . . So I had this constant friend and companion. I mean, this one would *never* leave, and if Lub laughed at me I could just insult him. But he was my own heart, you know? So me and Lub learned to get along."

"That's something else," Selma whispered. Abe could hardly hear her over the noises of the drives.

"Speaking of something else," Simon said brightly, "I wanted to suggest that we plan another trip to the symphony."

This drew a mixed review of moans and laughter.

"You think they'll let us in, with the racket we make?" Colleen asked.

"Oh, yeah. You weren't there. They did last time."

The others laughed.

Simon sneered. "We have to call ahead so they can give us special seating."

Abe glanced over at Colleen to see if she'd noticed the quick shift in the conversation.

She met his gaze, shrugged, and smiled.

Yes; she'd noticed.

"So what do you think about a trip to the symphony, Abe? Was it a problem last time you guys went?"

Abe chuckled, pushing the signal bar down for a left turn while they waited at a long light. He was glad she'd needed a ride home. "Not at all. Actually, it was hilarious."

"Hilarious?" She half smiled.

"That was last year. I wish you'd been in the group then. We made Simon call ahead first to warn them about the noise. They said it wouldn't be a problem. Well, we got there and found out why. They'd put us up in the balcony, as far away from everyone else as they could get us. But you know the acoustics in those places, right?"

"Yeah . . ."

"So of course our drives were echoing all over the place. People were staring."

"That doesn't sound funny."

Abe made the turn. A quick glance at Colleen told him she was getting depressed again.

"Now, don't get all serious like that," he told her. "I'm not done. OK, so we're up in the loge listening to the jet planes scraping the roof, right? Half a mile from outer space."

She smiled a little again. Abe went on with renewed vigor.

"About this time, one of the ushers came up, all embarrassed, and said the manager was getting complaints about the noise. We explained that there wasn't much we could do about it, so he left. Well, that set Simon off. He started grumping and complaining, and then Jason got into it, and pretty soon the rest of us were all getting sick of listening to them. The usher came back and talked to Mrs. B—sweet little old

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lady that she is—and then walked off again.

"Mrs. B started telling us that they wanted us to *leave*. Well, Simon didn't take too well to that, and the rest of us weren't thrilled, either. I mean, we'd called ahead and all."

"I imagine it made you pretty mad."

Abe grinned viciously. "We got revenge."

"I'm afraid to ask!"

"They were just finishing the next-to-last selection when Simon suggested we help them out a bit."

" 'Help'? Oooh!"

"You got it. Simon removed the front plate from his drive. You know how loud a drive gets without buffers. Mrs. B almost bust a gasket trying to get him to put it back on. Then Jason took off *his* plate. You could hear their hearts all the way down to the stage. The musicians started playing to mask the noise, so the rest of us—even Mrs. B—went along with Simon and Jason. It was really funny, too, because for some reason our heartbeats sort of synchronized into a staccato beat." He tried to imitate it: "Pud-rud-dud-prrmph, hiss!"

"I bet the theater manager noticed *that*. So you've never gone back?"

"Are you kidding? One of the musicians snuck up to the front of the stage and whispered to the conductor. Pretty soon they stopped playing. Our hearts were the only sound in the hall."

"Ho, boy."

"Then the cellist started playing something in time to the beat. The drummer followed, then the brass came in. Pretty soon the whole orchestra was keeping time to us."

Colleen stared straight ahead for a moment. Then she clapped a hand over her mouth. "You guys are *evil*," she muttered.

"Absolutely. We later learned that the orchestra member who started it all had a kid with an artificial heart. They'd done the same thing for him once when he came to a rehearsal with his dad."

"No!"

"Yes. So now we have a lifetime pass for performances. Floor seats. The only stipulation," he added, glancing at her sideways, "is that we call ahead."

Thump, hsst, thump. Hsst! Thump . . .

Abe's eyelids clicked open. Light from the overcast morning suffused the room. Dream-images fled his mind before the phone even had a chance to ring again.

He swung his feet to the floor and fumbled with the receiver. "Hello."

"Abe? This is Jason. Were you sleeping?"

"Ah, don't worry about it. What's up?"

"Bad news."

"What . . . ?"

"Selma's dead." Except for the exhaustion in each word, he said it in the most matter-of-fact tone Abe had ever heard.

"A malfunction?"

"No. She—it was—" Jason's voice collapsed in on itself. "It was a suicide, Abe."

Thump, hsst, thump. Hsst! Thump . . .

"How?"

"She took sleeping pills and didn't plug in her drive."

Abe paused, horrified. Then, "Where are you, Jason?"

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"Mercy Hospital."

. . . *hsst, thump. Hsst!*

"I'll be right there." As an afterthought, he added, "Who else knows?"

"Just Mrs. B. She's on her way, too. I'll call the others."

Abe stopped himself from offering to make the calls. Jason probably needed something to do right now, he thought. "Good. I'll be there soon, Jason."

Abe let himself fall backward onto the bed again. He stared at the ceiling until the sharp signal from the phone reminded him that he had forgotten to hang up.

"It's time—to go—get dressed," Lub seemed to be saying.

Time passed slowly after Selma's death. Abe had worked a few temporary assignments, repainted the stained wall in his apartment, and had dinner at Mabel's Cafe a few times. Roseanne had never been on duty when he'd gone there.

He often sat by the lake in the park. This time his knuckles were white against the dark green bench.

The artificial heart sensed his stress and pounded mercilessly. In the emptiness of his chest it felt alien and unwelcome.

Thump, hsst, thump. Hsst! Thump . . .

The others had described this feeling—it was the one they felt right after installment. Yet for Abe, it was new. Lub had gone in when he was so young.

The previous meeting, not to mention another possible trip to the symphony, had been canceled. There was supposed to be a meeting now, but no one had shown up. The last time he'd seen anyone from the group was at Selma's funeral.

Images of Selma flashed through his mind. She had been almost as beautiful as in life. If only the ashen hue hadn't shown through the undertaker's makeup. . . .

They'd buried her without her heart.

Ducks paddled by, their orange feet bright in the sunlit water. Insects hummed and buzzed. Leaves rustled in the miserly breeze. Abe tried to concentrate on the sounds; they helped drown out the loud cry of pain inside.

Thump, hsst, thump. Hsst!

No one. Had it *all* fallen apart?

"Hi, Abe."

"Colleen!"

"I brought some bread for the ducks."

Each word was steadily, deliberately calm. So she felt it, too.

He nodded. "Good idea." He took a loaf and began tearing off pieces to toss into the lake.

Colleen, less cautious, threw whole slices into the water, causing a panic among the hungry ducks. Within minutes they had devoured her entire loaf. A few of the bolder ones waddled up inquisitively.

"I think that one wants your finger," Abe told her.

"Oh, sure." She waved her fingers at the duck. It nipped her thumb.

Abe roared. It was the first time he could remember laughing since Selma died.

Colleen laughed, too, but something still wasn't right in her eyes.

"I talked to Jason today," she said.

"How is he?"

"How do you think?" Suddenly and

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without preamble, she asked, "Abe? Why do we keep on living?"

The words plucked some tender bit of tissue where his real heart used to be. "What—be—because we *have* to," he said weakly.

"No. We don't."

Her words made something crumble inside him. "Oh, God," he moaned. He leaned forward, holding his face in his hands.

"I shouldn't have come," she said quietly after a time. "I'm sorry, Abe. We'll talk some other time. I'll call you. . . . I'm sorry."

By the time he had collected himself enough to look up, she had gone. The ducks had wandered off to other parts of the lake.

A fading sunset filtered through the window to make orange patterns on the ceiling. Abe lay in bed, thinking.

Thump, hsst, thump. Hsst!

Why *do* we keep on living, Lubby?

Thump, hsst, thump.

Talk to me, Dubshit! Why do we do it?

Hsst! thump . . .

God, I *hate* you, you damned noisy—

The phone interrupted his internal dialogue. He tried to ignore it, but couldn't, and answered on the fourth ring.

"Abe? This is Colleen."

He didn't know what to say.

"I'm sorry if I was rude to you," she said.

He felt incredibly awkward. He had to say *something*. "Are you OK?"

"I'm—" She sobbed. "I'm just all mixed up. But I'm not suicidal. Abe, can we talk about this? About Selma? Please? I don't mean to—"

"I'll be there in fifteen minutes."

Abe hung up and reached for his pants. He tried not to think about the last time he'd dressed quickly after a phone conversation.

During the drive his memories ran amok. Usually he kept them tamped down enough to keep them manageable, but now they tumbled like a cascade in his mind.

His mother, crying quietly in the kitchen late at night; his father, shouting at nothing in other rooms.

The times they'd stopped his heart for maintenance on the pneumatic drive.

The second surgery for the first internal drive, and the third for the adult model.

The boy in the next bed who died the day before installation surgery.

The fear.

Selma's funeral—

The *loneliness*.

His hands shook on the wheel. Abe pulled over, taking a moment to be sure that he was on a deserted street. He secured the locks on the doors and rolled up the windows.

The sobs started from the bottom of his lungs. They quickly turned to ragged cries that were almost deafening in the closed car.

Afterward, he rested his forehead on the steering wheel. It had been a long time since he had last cut loose like that.

Relieved, he restarted the engine and pulled back into the street. He had to get to Colleen's apartment.

Colleen was waiting on the lawn

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when he pulled into the complex. Even by the dim glow of the headlights, Abe could see that she had been crying, too.

She pulled open the door. "Do you want to go out?"

He nodded.

She glanced at his eyes, nodded in return, and got in.

"Any place in mind?" he asked. He tried not to sound nasal.

"Maybe we should stay here."

Abe smiled sadly. "We're both a mess, aren't we?"

She returned the smile. "Disaster areas."

"We'll pull through."

"I talked to Jason earlier tonight. He's doing better than I expected, but you can hear the pain in his voice. He's going to live with his sister in Oregon for a while." She shook her head. "I didn't know what to say, Abe. That's why I wanted to talk."

"How can I help you with—about Selma?"

"By *talking* about her!"

Abe sat back and let out a short breath. "Talking doesn't always solve problems, Colleen."

"Why is everyone so cold about Selma?"

"What good would crying and screaming about it do? We're all scared to death of what happened to her."

"Scared isn't the word! Here we are, all trying to cope with these . . . *machines*"—she said the word with unhidden contempt—"stuck in our chests, and damned if Selma didn't use hers to kill herself. We tried to help her, Abe." Her voice rose. "But we can't even talk about how hard it is, surviving this way. What happened to Selma could happen to any of us. And we didn't help Selma. Why, Abe?"

Abe's eyes, though swollen, could still cry. "I don't know why, Colleen. You're right. The group went wrong. We started hiding our feelings instead of dealing with them—the same way we do with normal people."

"For God's sake, Abe, we aren't freaks."

"Sometimes it feels that way. I don't know why she killed herself. I don't know why we have to have these machines in our bodies. I don't even know why we keep on living. I don't know. At least not right now. I just don't *know!*"

Colleen moved her PEPD until it was against the car door. The tube snaked awkwardly between her and the seat.

"There were times I wanted to give up. When I was sixteen I almost killed myself." The edge in Abe's voice softened. "But something made me plug in the drive again. There was an old man lived up the street. He let me call him 'Grandpa.' I'd go over to Grandpa's house and we'd play checkers or toss a baseball with me sitting in a chair. Sometimes we'd sit on the porch eating cookies." Abe chuckled. "I found out years later that he'd called my mother to be sure the cookies wouldn't hurt me, but you know, Colleen, he never mentioned that to me. With him, I was just another kid. The heart was no more important to him than Janey Sutter's braces."

Colleen readjusted the tube and turned toward Abe.

"He died when I was fifteen. I almost gave up. Oh, I wouldn't really have died—I hadn't taken pills and Lub's

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power alarm would have woke up my parents—but what mattered was, I had the choice, and I chose to live. I knew I wouldn't *always* feel like an outcast. That old man gave me that."

Colleen nodded. "I understand. I was always sick as a kid, but my parents let me go to camp, sing in choir—normal things. It scared hell out of them, but they knew I needed it."

"Selma's family must not have known that. Technology is fine for most people as long as it doesn't hurt. But sometimes it hurts *bad*." He turned to her. "Us, Colleen, we can't turn away when it gets ugly. We can't pretend we're safe. I grew up with specialists and nurses and scared parents—with adults. When people touched me it was to give injections or take heart measurements."

"You never quite felt like a normal person."

"No. I didn't."

They paused.

"There's nothing wrong with you, Abe. There really isn't."

She tried to kiss him, but he dodged her. She drew back, puzzled. Hesitantly, she touched his shoulder.

Abe reached back, and clung to her like a man clinging to flotsam in the ocean.

Abe paced in time to his heartbeat. The agency hadn't called with any assignments, and he hadn't heard from Colleen since that night earlier in the week.

He wasn't particularly sure why he had chosen to come this way. The sidewalk would pass the hospital where he'd gotten his hearts installed.

She probably wanted to avoid him. Why on Earth couldn't he handle his own emotions without acting like that? Would she leave the support group altogether—if there even still *was* a support group?

He felt like an idiot.

"You fool—you fool—you fool," Lub droned.

The sigh of bus engines mixed with the chatter of sparrows and squirrels in the trees lining the walkway. The squirrels jumped frantically in the branches. Irrationally, Abe hated them.

"Why live?—Why live?—Why live?" Lub demanded.

Doctors would say he had to live for the sake of survival alone. Specialists would point out that his survival helped other patients, through research and development of the heart. A priest would say live for spiritual growth; a friend, for understanding and affection; and most people would answer the question with a shrug and a look of disbelief, as if the answer was obvious.

But it wasn't obvious when you were forced to pick it apart. How would he answer Colleen, assuming he saw her again? Trump up good meals, sunny days, friends, that sort of thing? Each pleasure was limited by the artificial heart. Eating habits and mobility were affected every moment of his life. Friends were rare, and lovers impossible to find. Who wanted a man who had to shift his drive unit just to hug?

"Col-leen—Col-leen," thumped Lub.

He shook the thought from his mind and paced through the hospital entrance. The gray-tiled floor was the same, but the wooden reception desk had been replaced by a circular plastic station. The lobby had also been remodeled. The

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elevators were new, too, as Abe discovered on his way to the cardiac ward.

The nurses glanced up from their station, smiled, and returned to their paperwork. Nearby an intern scribbled on a clipboard. They seemed unconcerned. Abe wondered if adult artificial heart patients came in often.

Lost in thought, Abe was passing the playroom—it had been remodeled, too—when he almost bumped into a little boy. The child stared up at him with wide, hazel eyes. Abe recognized the pallor of the boy's skin. Cardiac insufficiency, he thought, recalling the term, what it meant, and how it felt.

The boy shuffled off, not running as a normal child might, and disappeared into a room.

Abe went back to the nurses' station. "I just saw a little boy," he told no one in particular. "Brown hair, hazel eyes. He was wandering in the hall. You might want to look after him."

One of the nurses strode down the corridor. The intern looked up from his clipboard, put his pencil behind his ear, and nodded to Abe. "Thanks. You know how the kids get before surgery. He's due for an implant tomorrow."

"He's getting a Lub—a PEPD, huhh?"

"No. One of the new ones."

"New?"

"Yes. Internal drive."

"No kidding? I thought those were still experimental."

"They were, until a month ago." The intern jerked a thumb toward the hallway. "He'll be the third child to get one. I see you have the external model."

"Had it since I was a kid. Two drives; the first was non-portable—and three hearts. The first was a Jarvik-Smith. The second two were Winchells."

"Wow. Sounds like you've been through a *lot*."

Abe's eyes widened for a moment. "Yeah."

The intern pulled the pencil from behind his ear and waved it for emphasis. "For what it's worth to you, there's a lot of work being done to make internal replacement models for your type of drive. It's tricky, though. Those external drives required a lot of tissue removal from the chest. But really, your chances are good. You may not be carrying that PEPD many more years."

Abe scowled. "You know how it is with experimental medicine. Testing won't start for years."

The intern smiled sympathetically. "I can understand your impatience. Still, you know we can't take unnecessary risks in the medical profession."

"In this business, is there any such thing?" Abe put his hands flat on the nurses' station. "Do you know I'd *die* if I knew it would keep another kid from growing up the way I did?"

For a moment the intern seemed taken aback, but he recovered quickly. "You didn't have to die. The drive that boy is getting was originally developed for the Winchell you have now." He put the pencil back behind his ear. "If you *had* died, his chances for an internal drive would have ended. His best hope would have been a transplant. You know how miserable those are. . . ."

The intern kept talking, but Abe hardly heard.

Mrs. B's eyes shone. "Thank you for

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stopping by. And thank you very much for the candies."

"We got them special order from a little health food store downtown," Colleen said. "It was the first time either of us had seen decaffeinated chocolate."

Abe smiled. It had been a week since he and Colleen had talked in the car, and she seemed to have deliberately forgotten about his outburst. In fact, she seemed unusually cheerful.

Mrs. B sighed ecstatically as she finished another candy. "I'd forgotten how much I loved chocolate."

"We dropped off a package for Simon, too, and mailed one to Jason," Colleen told her.

"Yes." Mrs. B's eyes softened at the mention of Jason's name. "How is he doing these days? Has his family been able to help him?"

"I've been talking to him on the phone," Abe said. "He's doing volunteer work at a hospital near his sister's home. It seems to help."

"I called him earlier this week," Colleen added. "We talked about Selma. That was the first time he mentioned her since . . ."

"I know." Mrs. B looked down and sighed. "But if you've gotten him to talk about it, then he should be all right."

"He said he'd be coming back into town sometime around the sixteenth." She glanced at Abe. "We wanted to organize a meeting for the nineteenth."

Mrs. B nodded slowly. "That would be fine. It's time." Then, in a brighter tone, "It will be good to see the group together again, won't it?"

Colleen nodded gently. "It sure will. The nineteenth, then? In the park. My apartment, if it rains."

Abe and Colleen stopped at the lake after leaving Mrs. B's house. They went to the same bench they'd sat on the week before. The overcast sky made dull silver reflections dance on the water.

"Last week, you asked me why we keep on living," Abe began.

"I was depressed. But listen, Abe, I don't feel—"

"You don't need to make excuses, Colleen." He paused. "Something happened the other day that helped me. I went to the cardiac ward where I had Lub installed."

"Why?"

"I don't know. There was a little boy there, Colleen. An intern told me he was in for an implant. *Internal* drive. No hose-and-box stuff. He'll hardly be different from other kids."

Her eyes widened. "I didn't know the internal drive had gotten past the experimental stage." She glanced at him cautiously. "Anything like that in the works for us?"

"The intern said there's research into that idea. That means we probably won't be linked to these drives much longer."

"We'd be so much happier," she breathed.

Abe nodded. "In the future, there will be thousands of kids like that boy, Colleen. They'll all be happier because of us."

She gave him a questioning look.

"Selma's death was the worst kind of tragedy. Whether or not she died in vain depends on us. We have to learn from her. We see the destructiveness of

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the external drive in a way doctors and scientists wouldn't, if there weren't Selmas. But by surviving we make the drive practical—and when it's practical, it can be improved."

Colleen nodded with understanding. "It's almost sick, but . . . her dying the way she did—"

"It's called suicide."

"Ugly word. Her suicide says a lot about what it takes to live with an artificial heart."

"In a strange way, yes, it does. But, Colleen, our survival says a lot more. It's the same thing that happened with kidney dialysis back in the 1970s and '80s. The suicide rate was horrendous, but what mattered was, most patients survived in spite of the misery. That's why internal dialysis is routine now."

Colleen sighed. "I just wonder how many people know the real price of it all. The human price."

Abe grunted. "You'd never know from the way they treat us."

"Not everyone is stupid about it, Abe. How about the orchestra? Or—" She hesitated. "Or . . ."

"See? There just aren't that many normal people who can handle seeing the pain on a personal level. So they drop coins in collection tins instead. The end result, though, is real enough. There's a kid getting an artificial heart who won't need to name his PEPD. And that's because of two things: practicality—we survive; and emotion—people do care."

"Boy." She shook her head, smiling, and stared out across the lake.

"Seems to me there's a reason to keep on living there."

"Yes." She laughed. "With this kind of thinking, you almost make me feel guilty."

Abe gave her a look. "What are you talking about?"

She turned to him, her eyes shining. "I found another reason to want to survive. A purely selfish one. Abe—I think I'm in love!"

His heart sped up. He steadied his hands by clutching the edge of the bench.

She laughed nervously. "You think I'm crazy."

"Try me."

"His name's Adrian. I knew him back in high school, before he moved out of state. He got back in town a day or two after we—I mean, that night—anyway, I think he's nuts about me, too. We'll be going out tomorrow."

Abe's voice began as a whisper and rose to a roar. "Who *is* this Adrian guy?"

"Abe?"

His drive hit maximum speed. "A high school friend? In town for four days, and you think you're in love? Are you nuts?"

"What do you—"

"Give me a goddamned break, Colleen! You don't even know this guy!"

"You're getting irrational!"

He stood, grabbed his drive from the bench, and glared. "Irrational? Christ, Colleen! What about when you get sick, or need more surgery? You think he'll be there for you? How about children—you know how hard that would be. And lovemaking, with the drive in the way? And—and—"

"For Pete's sake, Abe, it's not like we're getting mar—"

"What about *me*, Colleen?"

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Blinking hard, Abe turned and strode away.

He spent the rest of the day walking, and most of the night listening to old albums. By the next morning his heart finally slowed down.

Two cups shattered in his hands while he washed last night's and this morning's dishes. He tried vacuuming, but became exhausted before he was half through. After a short nap and a snack he became restless. He didn't want to go to the park. After some thought, he decided to stop by Mabel's Cafe.

Roseanne saw him first. "Abe? Are you OK?"

"Sure. Why?"

"You look sick. You're pale."

"I'm fine."

She glanced at him sideways. Abe could tell she wanted to say something, but thought better of it. He looked away.

Moments later she firmly placed a coffee cup on the counter before him. Abe looked up and saw Roseanne with an orange-rimmed decanter.

"Decaf?"

"Sure. Thanks."

She paused. "Didn't you notice?"

Abe scrutinized her carefully. "You changed your hair?"

"He finally moved it." She pointed to the air conditioner, which now resided in a front window.

Abe tried to laugh. "I'll be darned."

She crossed her arms. "You're not convincing me."

Abe raised an eyebrow.

"That you're fine. You're not convincing me. What happened?"

Abe gritted his teeth and thought of thousands of children who would never have an external drive. It didn't help.

"I'm on break, Steve," Roseanne called to the heavyset cook, who grunted in reply. "Come on," she told Abe, and grabbed his free arm, waiting for him to pick up the drive with his other one.

She led him behind the counter and into the back room. "Now, what happened?"

"It's not that big a deal—"

"Look. I'm forty-six years old, I have a kid and no husband, and I make a living as a waitress. I know when something's wrong. So talk!"

Abe eyed Roseanne for a moment. Her demanding concern both irritated and touched him. "What do you care?"

Her eyes flashed. "Do you know that I'm the only person here you talk to? I'm not dumb. Sometimes your pain is so heavy it's like a Siamese twin on you. It hurts me just to see it." The hardness in her eyes turned to pleading. "Now, something's wrong. What is it?"

"I'm . . . her name's Colleen."

"Now we're getting to it. She dumped you?"

"Well . . . yes."

Roseanne rolled her eyes. "For God's sake, is *that* all?"

The tin can bounced and clattered ahead on the gravel pathway. Abe noticed that it was already heavily dented. He walked up and gave it another sharp kick.

He'd never gone this far into the woods behind his apartment before. At the moment he didn't much care. His mind was tumbling with Roseanne's words, and alternately with fantasies

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that Colleen would magically appear to tell him how wrong she'd been. Abe was beginning to understand how his beaten pair of blue jeans felt when they were in the dryer.

Roseanne was right; he was feeling sorry for himself. Other people—*normal* people—lost loved ones and got sick and had unsolvable problems and—

And it still hurt and he was still grieving and he might as well admit it and kick the dumb can around until he felt better.

Roseanne had said a lot in ten minutes. How many times had he done what she'd said—let the technological wonder in his chest eclipse his view of who he was? How often had he pushed away people because of his own pain? He was angry at them for not giving him a chance. But who was rejecting whom?

Colleen might have acted differently if he'd just told her he loved her instead of roaring and walking off.

Who could blame him, though, with everything he'd been through?

Abe kicked the can again, half-heartedly. Those normal people who had so often turned away or been hostile had no right to distort his relationships. He would never entirely forget his anger. Maybe, though, he could learn to stop throwing it at innocent victims.

From now on that wouldn't be allowed to happen.

Abe drew his leg back and sent the can sailing into the trees.

"Colleen, *please* talk to me."

The receiver was silent a moment. Then, "After the way you acted last time, I'm not sure I should."

"I was upset. I'm sorry."

"Well—" She sighed. "All right. I'll meet you in the park in twenty minutes. On the bench by the lake."

"Thank you."

"But if you try to yell at me again, I'll roll you in bread crumbs and leave you at the mercy of the ducks."

Abe laughed, and was relieved to hear her laughing, too.

She was waiting on the bench when he arrived. He handed her a dandelion blossom. "Peace offering from Chief Roaring Buffalo."

She gently laid the flower beside her on the bench. "Accepted."

He sat down. Two drakes swam near the shore while a female with ducklings waddled toward them.

Abe began to giggle. Colleen eyed him suspiciously.

"Sorry. Your comment about rolling me in bread crumbs. . . ."

"Oh," she said, and smiled.

Abe quieted.

"Well, we're going to have to get down to it," she said. "Why did you stomp off like that?"

"You know why."

"Yeah," she breathed, "but I wasn't sure."

He turned to her, thinking he understood her meaning, but seeing that he didn't. He waited.

"I didn't grow up like you did, Abe. I haven't had the artificial heart all that long."

"I know that."

"Let me finish."

He nodded.

"Even though I wasn't so obviously different as you were, my health still affected the way I thought. If I wasn't

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thinking about how to take care of myself *all the time*, I was in real danger. That made a lot of people uncomfortable. It must have been the same for you."

"Yes. It was."

"You didn't get selfish the way I did, though. You seem a lot more aware of what other people think and feel."

Abe winced inwardly when he thought of Roseanne's lecture.

"—So maybe you'll forgive me for not seeing what was happening with you." She sighed. "Maybe that's why I turned the business with Adrian into such a big fantasy. I don't know how —I'm not ready, I guess—to fall in love."

"You're not . . .?"

"No." She said the word with disgust.

"Last week you tried to kiss me."

"That doesn't mean—" She stopped herself. To Abe's surprise, she kicked at the ducklings, which scattered.

"Colleen!"

"Oh, I'm sorry. I'm angry. I knew they'd get out of the way." She looked back at him. "You've got me all confused."

"Well, don't take it out on baby ducks! Confused how?"

"I like you. A lot. But we've both been so emotional with Selma's death and all. I just don't think we should try to get involved right now." She faced him with terrible sadness in her eyes, but no tears. "I've seen enough disasters. I couldn't take another one."

"Who says it would be a disaster?"

"Who says it wouldn't? And if things don't work out, what about the support group?" She turned away. "You want me to risk too much. I hardly have a friend left because I've been so upset, adjusting to the heart and Selma's death. Now you want me to love you." She crouched and held out her hand to the ducklings, which ran to investigate. "It's too much. I can't give that. Not now."

"I love you."

"I know! And I'm not saying no. I'm just saying, let's be friends a while longer, OK? Get together for coffee, feed ducks, whatever. But as friends, not lovers."

"That's fine."

"Really?"

"For sure. I understand. Believe me." Abe picked up the dandelion and handed it to her again. "Friends. Always."

They paused.

"I never named my external drive," Colleen commented. "You know what? I think I'll call it 'Dandelion.' "

"Dandelions. Pretty weeds. I like it." Abe smiled at her and gently clasped her hand, careful not to damage the small blossom. "Nobody wants a dandelion, but it's not only pretty; its useful too. They make great wine."

Abe shifted his drive. This time he reached for her, and the blossom fell to the ground, forgotten. ■

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The Alternate View

REPORT ON NANOCON I

John G. Cramer

Nanocon 1: The First Northwest Conference on Nanotechnology was held at the University Plaza Hotel in Seattle, Washington, on February 17-19, 1989. The conference was sponsored by the Seattle Nanotechnology Study Group and the University of Washington Student Nanotechnology Study Group. This AV column is a report on the conference.

Those of you who read the article "Nanotechnology" by Chris Peterson and K. Eric Drexler, published in the December '87 *Analog*, will be familiar with the term *nanotechnology*. It was coined by Drexler in his book *Engines of Creation* (EOC) and refers to the *nanometer*, a distance of 10^{-9} meters or several atomic diameters. Nanotechnology is the technical capability, not yet fully realized, which will make possible the structuring of matter with precise control at the nanometer scale, atom by atom or molecule by molecule, to form a specified pattern. Nanotechnology is the general ability to build large or small structures to complex atomic specifications. Notice that nanotechnology refers to the *technique* and *ability*, not the size or scale of the product. Nanotechnology constructions need not necessarily be small.

Nanotechnology differs in important ways from the *micro*technology (10^{-6} meter scale) presently used by the electronics industry to produce integrated circuit chips. The tools that assemble nanomachines can themselves be tiny assemblies of atoms. If even one general-purpose assembly nanomachine or *assembler* is available, it can be used to rapidly construct more identical assemblers in a geometric progression. It can rapidly mobilize as many assemblers as are needed to construct even very large structures from the available materials. Nanotechnology in effect can reduce all construction and manufacturing to a matter of software, of designing the command set that will specify the desired atomic structure and the steps required for its fabrication and assembly.

But the most striking aspect of nanotechnology lies in its biological implications. The cells of our bodies are, in essence, nanostructures. They even contain a specialized form of assembler, a nanomachine called a *ribosome*, which can and does assemble any protein from the command-steps encoded in linear RNA molecules. One implication of nanotechnology is that the biological functions of human cells can be directly controlled, repaired, and in some cases improved. Complex nanomachines that fit easily within our cells can take over their management and repair. The coming mastery of nanotechnology offers the promise of cures for cancer, hemophilia, diabetes, and other genetic disorders; the promise of the absolute elimination of all the parasitic, bacterial, and viral diseases that afflict humanity; the promise of the reversal of aging and extension of the human life span; the promise of the enhancement

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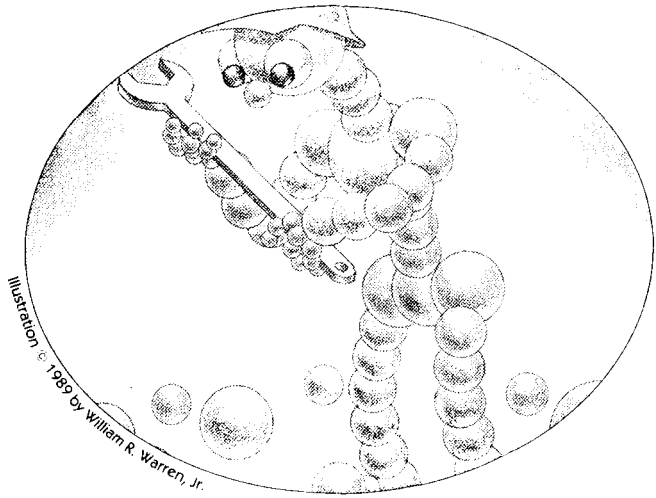

of human strength, endurance, sensory sensitivity, and even intelligence. And it also poses awesome threats and dangers arising from the many possible misuses of these new capabilities.

As a technological revolution, nanotechnology is perhaps unique in human history in one important way. Its arrival, its impact, and its problems have been thoroughly anticipated, largely through the work of Drexler, *well before* the actual technology is at hand. This did not happen with the industrial revolution, the nuclear age, the space age, or the computer revolution. A foreseen major revolution is unprecedented. There are several evident technological paths that will lead to nanotechnology, but it will be many years, perhaps many decades, before the full impact of these promises and problems will be upon us. We have time to consider, to steer development, to devise solutions to the problems. That is the point of this conference.

* * *

The Nanotechnology Conference opened with a banquet featuring a keynote address by Drexler. He described the state of nanotechnology as a developing field of inquiry and research, with emphasis on new developments, directions, and challenges. He pointed out that in 1988 a significant milestone predicted in EOC was achieved: the first useful protein with no equivalent in nature had been successfully synthesized in the laboratory, a designed protein that is more stable than natural proteins. The age of engineered protein construction has arrived.

The conference participants were an interesting mix of academics, students, scientists, engineers, biologists, programmers, space advocates, and writers of both fiction and nonfiction. Some of the most original views expressed during the conference came from the attending science fiction writers. Perhaps this should not come as a surprise, for SF writers as a group have devoted much time to studying the implications

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of possible future technologies. Greg Bear, Gregory Benford, Vonda McIntyre, Marc Stiegler, and I participated in the programming, and other SF writers in attendance contributed to the lively and far-ranging discussions.

The Saturday program began with a talk by Eric Drexler on rod-logic computation. The capabilities of nano-scale computers that use electric currents are difficult to assess, because their properties are not well specified and their operation will necessarily lie in the domain where quantum mechanical interference phenomena are important, even dominant. Therefore, as a way of getting some realistic estimate of how much computing capability might be packed into a nano-scale computing device, Drexler has gone all the way back to the 19th century and the rod-and-cam computing devices designed by Charles Babbage, substituting stiff carbyne carbon-chain rods for Babbage's brass shafts and molecule lumps for Babbage's machined brass cams. A computer constructed in this way is in principle possible and might even be mechanically robust. It offers the advantage that it can be readily analyzed for speed, capacity, power consumption, etc. It turns out that nano-scale rod-and-cam technology could be used to make a remakably powerful computer. Drexler demonstrates that it is feasible, in the sense of not violating any physical laws, for a Cray-II class computer of this construction to be fitted into a small fraction of the volume of a cell, with plenty of space left over for nano-manipulators controlled by the nanocomputer and its software.

* * *

Profs. Nadrian Seeman of the City University of New York and Bruce Robinson of the University of Washington described their work on nucleic acid structural engineering which, as a currently available nanotechnology, represented a technical high point of the conference. They discussed the construction of rigid mechanical nanoscale structures that are made from DNA chains. Readers will recall that in cells DNA is not a structural material but a sort of reference library of protein designs, from which RNA transcriptions are made and sent to ribosomes for protein production.

But Seeman and Robinson explained that, as structural material, DNA offers several very interesting advantages: the chains are relatively rigid, can be made in the laboratory to designer specifications using solid-phase synthesis techniques, and will link, lock-and-key fashion, only to the complementary sequence of bases of another DNA chain. They have produced several carefully designed DNA sequences that link to form three- or four-way junctions with "sticky" ends. These then become the units of a sort of "Tinkertoy" construction set, from which complex two- and three-dimensional structures can be assembled with DNA rods and junctions. The uses for such DNA scaffolding in nanotechnology are not yet clear, but one possible application, as Robinson pointed out, might be for the conductors and switching junctions of current-mode nano-scale computers and memory devices. Another use might be to provide a relatively rigid and predictable framework upon which a true nanomachine

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might be fabricated.

The Saturday afternoon discussion focused on hypertext publishing. *Hypertext* (see Marc Stiegler's article in the January '89 *Analog*) is the ultimate generalization of the printed reference book, a large computer network with very large information storage and correlation capacity used for information searching, cross-referencing, discussion, criticism, and publication of new results. This concept is not nanotechnology, but in EOC Drexler suggested that hypertext publishing might uniquely keep pace with the rapid technological progress of nanotechnology and address the problems inherent in it. Speakers, including Drexler, Marc Stiegler of the Xanadu Corporation, and L. Roberts of the Boeing Company, discussed the general concept of hypertext and its recent commercial implementations. These new systems, particularly the one being developed by Xanadu, may soon provide a reasonable approximation to the hypertext system envisioned by Drexler in EOC.

Sunday morning was devoted to a panel discussion on the social issues of nanotechnology. The discussion was very broad in scope. Gregory Benford made a particularly interesting point during this panel. He suggested that some "precursor" social effects of nanotechnology are already here and should soon become more evident and important. When a large fraction of the population *believes* that nanotechnology is coming and will soon be a technological reality, they will, even before the technology is available, begin to act on the assumption that *it will be developed*. This will have social consequences.

Benford illustrated his point with the *cryonics* movement—the several organizations that on the death of a subscribing member undertake to cryogenically preserve his or her head or entire body, making it possible for some future technologically advanced society to make the necessary repairs and restore the "sleeper" to life. A few years ago this kind of resurrection seemed a very remote possibility. But with the advent of nanotechnology it seems much less a long shot. Benford predicted that with rising public awareness of progress toward true nanotechnology there will be a large growth in the cryonics movement. (Benford, incidentally, is now planning an SF novel dealing with this subject.)

In the discussions of social issues during the panel, a certain pattern emerged. The discussion would tightly focus on a particular impact or line of development (the impact of human life extension on present retirement programs, for example) while implicitly assuming that the rest of the social universe was somehow frozen, unchanging. Drexler made an important point, cautioning that the approach of changing one thing while holding everything else unmodified, as is often done by engineers in analyzing complex electrical or mechanical systems, can lead to seriously wrong social conclusions. He pointed out that in a real society a large number of things will be changing at the same time. Predictions which ignore societal changes on a broad front may be unduly alarming (e.g., predicting bankruptcy of retirement pools) and

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probably incorrect. More realistic assessment of the social problems arising from change require a broader approach, where many social factors must evolve and adjust together. Someone commented here that what we really need for analyzing the impact of nanotechnology is Asimov's psychohistory.

The Sunday afternoon panel discussion, which I moderated, was an interactive workshop on paths to nanotechnology. We started by describing the various technological paths which lead from where we are to the realization of nanotechnology, and the ways in which each of these paths is presently blocked. The focus of the discussion shifted to the biological path, using the protein-producing machinery in cells to produce new nanomachine designs that can lead to a generalized assembler. This line of development is presently blocked by our inability to fully understand the operation of the ribosome or to predict how a protein with a particular sequence of amino acids will fold itself as it is created and becomes biologically active.

Prediction of protein folding is presently blocked by the difficulty of the computations. This led to discussion of the state of supercomputers and of radical new computer architectures such as neural-network circuits, and how these might lead to a solution for the folding problem. The intrinsic instability of neural nets was mentioned. There was also discussion of the general problem of biological complexity: are we humans really smart enough to master all the complexities of natural biological organisms, their structure, and their operation?

Those at the conference were optimistic, for there is presently steady progress toward resolving these complexities. Many of the conference attendees and many more workers not attending the conference will continue to bang away at the countless stumbling blocks between us and true nanotechnology. In the years and decades that will be needed to go from here to there, those of us who write hard science fiction will try to anticipate some of the triumphs and some of the problems that will inevitably arise as this newest of technologies moves from the sidelines to the center of the stage that is the world. ■

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THE LONG WAY HOME

Doug Beason

"First aid" is usually thought of as something applied to *people*. But not necessarily. . . .

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Bouncing off the shuttle's flight instruments, Lance Wasserman didn't look like an athlete, much less a hunk. And he sure as hell didn't handle himself like a superstar as he was herded off the *Discovery*.

The picture from the shuttle was crystal clear on the tube. Taken not more than 100 meters away from where I sat, the image was bounced from the *Heinlein*'s low Earth orbit, down to Earth and back up again.

As Lance Wasserman pulled himself into the *Heinlein*, I made for the bay. On a second thought, I pushed back to check the mirror. *Great*, I thought, *Mascara City. What in the hell had I been thinking of when I was putting on my makeup?* Embarrassed, I pulled away chunks and tried to wipe the excess away. Moments later I ran a comb though my bangs. Even if my hair wasn't as long as it had been back on Earth, I still looked presentable enough for the press geeks. *Dr. Judith Roviola, station director and bitch of the spaceways*. I grinned wryly at my image before heading out. One more chance for the so-called Ice Lady to prove herself; pull this off and maybe I can get the hell off this station and back to a real job, where I can use my Ph.D. Just coddle the jock for NASA, he'll be gone soon enough.

The *Heinlein*'s spokes spread out in front of me, connecting the crew quarters with the rest of the space station. The spokes—tubes, six meters across—ran into the central complex where the *Discovery* had docked. I pushed off and took one last chance to smooth my coveralls; I was serious about first impressions. Bouncing slightly, I drifted into the room. A crystal view-port was set in the bulkhead behind the crowd of people. The Earth would have made up most of the view, but it was partially concealed by their heads.

"Dr. Roviola!" "Excuse me—" "May I have a word—"

Hanging onto handholds, the press delegation shoved their microphones into my face, pushing me backwards. Two of the press geeks were throwing up, sending the station staff scurrying to clean up the globules of vomit floating in the chamber. What a zoo.

I searched for Dr. Pallin, the NASA bigwig and ex-astronaut who accompanied Lance Wasserman on the flight. Now heading up Space Station PR at Johnson Space Center, Pallin was a fast burner in the NASA management line—and a nanomanager to boot. I couldn't see him for all the brouhaha. Grabbing a handhold, I raised my voice over the din.

"Ladies and gentlemen . . . *please!*" As they quieted, I spotted Dr. Pallin. Floating next to Pallin and with his helmet off, Lance Wasserman looked like a Greek god—and unlike every other spacesuit in the room, besides the orange "7" painted on the front, his suit clung tightly to his frame. All six feet five inches of it. I drew in a breath. Close up he *was* a hunk.

Lance grinned and held out a hand. "Dr. Roviola?"

"Mr. Wasserman." I shook his hand firmly, surprised he didn't crush my hand. I nodded briskly to Dr. Pallin.

"Welcome to the *Heinlein*, sir. How was your trip?"

"Delightful." Floating up, he seemed

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hesitant, as if waiting for me to snap at him. Pressing his lips together, he said, "Lance has agreed to an interview after the tour. We'll tape him as soon as you're done. The press wants to carry it out on the evening news."

"Fine." I said. "We can use the viewport as a backdrop." Just visible through the crowd, the *Discovery* floated in black stillness, with Earth hanging serenely behind it. Pinpoints of stars dotted the background.

Lance tossed his helmet from hand to hand, using it like the football he was so good at throwing. He moved slightly back and forth with each movement.

Lance said, "I want to thank you for spending your time, offering to take me around up here."

"No problem, Mr. Wasserman. NASA is glad to assist you any way we can. The *Heinlein* needs all the positive exposure it can get, especially with the budget cuts."

He nodded and craned his neck as he looked around. "This is really fascinating."

"Thanks. If you're ready, we can start the tour. Just remember everything you learned down at Houston—" I nodded to his helmet—"even staying one day, that shouldn't be out of your reach."

He grinned again, and flipped the helmet "up". . . . it shot to the ceiling, and bouncing off, came careening back, straight for my head. I ducked, and a massive arm shot out and caught the helmet right before it hit me.

"Sorry." Lance reddened as he rotated around.

"S'all right." Releasing the handhold, I brushed myself off. That confirms it, I thought. There's more vacuum inside that gorgeous head than outside the space station. It was time to put aside my schoolgirl fantasies and get down to business; after all, I've got a station to run and a nasty reputation to protect.

Delighted at Lance's amiable nature, the press started up their video cameras. One of the cameramen yelled out, "Hey, Lance. How about some pictures?"

Now hanging upside down with respect to the press, Lance twisted to pose for the man.

Dr. Pallin swam over to my side. He spoke out of the side of his mouth. "Make sure he's impressed—and for heaven's sake, be nice to him, Judy. Remember who he is."

How could I *not* know? Locking myself in my room every Sunday, listening to the football games over headphones while playing classical music out loud in case of unexpected visitors. . . . That's another reason for heading back to Earth: privacy.

I nodded toward Lance and said, "Don't worry. Quarterbacking three straight Superbowl teams hasn't exactly made him an unknown."

Pallin looked pained. "Just don't blow it. If we can get him to say he supports the *Heinlein*, it's clear sailing past those congressional cuts."

I smiled sweetly at Pallin. "Don't worry. I'll use the KISS approach." Pallin lifted an eyebrow. I patted his arm and said, "It's what we use for the congressional tours: Keep It Simple, Stupid."

Pallin opened his mouth as I turned my attention to the press.

"Ladies and gentlemen, I'm sorry,

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but we can't fit everyone in our labs at once. If you'll follow the crewman to the control room, we have a briefing set up for you while we show Mr. Wasserman around. He'll meet you there shortly." I pushed off as three crewmen herded the press corps away, taking care to snag those who were having trouble with the free fall.

Approaching Lance, I steadied myself by grabbing onto his elbow. You learn not to be shy on board the *Heinlein*—it's the only way to exist in zero-gee. His body slowly rotated from stopping my inertia.

"Mr. Wasserman, if you'll follow me, I'll take you through the laboratory complex. The *Discovery* is scheduled for a quick turnaround, so we've got to get you and the press back after our supplies are unloaded. We'll hit the crew chamber, and if we have time before the interview I'll show you the EVA facilities."

"EVA . . ." Lance hesitated.

"Extra Vehicular Activity—any activity outside the space station." I translated.

"Sure." He turned to the view-port, rotating his massive body. "The view is just incredible. Can I go outside first?"

I frowned. "Excuse me?"

Lance gestured to the view-port as Dr. Pallin herded the last of the press corps toward the control room. "Outside. You said an EVA. Can't we do that first?"

"I said we'd *tour* the EVA facility. That is, the airlock and maneuvering units. You can't go outside."

"Why not?"

I blinked. Does the man understand English? Drawing in a breath, I said slowly, "Mr. Wasserman, we operate under very strict rules here. They apply to everyone, no matter who they are, or how important they may be. The rules are carefully designed to maximize our survival. Even though the press may have popularized living on board the *Heinlein*, I can assure you that it is still a space station in an experimental stage—it is dangerous here and we cannot afford to take chances."

Lance continued to smile. What made it even the more frustrating was that his grin widened. He spoke softly.

"I appreciate your concern, but I assure you I—"

"Judy, what's the problem?" Dr. Pallin steadied himself on my elbow.

I set my mouth. "I was just explaining to Mr. Wasserman that NASA prohibits any EVAs by civilians."

Pallin moved his arm to my shoulder. He squeezed lightly and sounded jovial. "Mr. Wasserman is a big boy, Judy. Those NASA directives were set up to prevent the congressional staffers from hurting themselves. And it's not like the regulations are carved in stone. You were on the team that first established them, weren't you?"

"Dr. Pallin, I can't take the responsibility for breaking a key directive." I didn't budge.

Pallin's grip tightened, but the grin remained plastered to his face. "I'll take the responsibility, Judy. I'll clear it through Houston. Lance has used his suit back on Earth and has been drilled in the emergency procedures. I'm sure that with a tether line tied both to the *Heinlein* and to yourself, nothing will happen."

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Lance narrowed his eyes. "I don't want to cause any problems."

"It's no trouble, Lance." Pallin turned his attention to me. "Are you willing to go along with that?"

I drew in a breath, trying to stop my face from turning red. *Of course it's all right,* I thought. *What the hell does he want me to do—put down my foot and say no?* Pallin's position at NASA is pretty clear, and by this time next year he might even be appointed director. Better to back out of this situation before Pallin starts feeling his oats and volunteers to take Lance out himself. He's just another damned ex-astronaut who thinks he's still got his spacelegs.

Why can't they leave me alone and let me run the friggin' station? I suddenly felt tired, ready to give all of this up—but I knew I couldn't. They'd say I couldn't hack it, and I could kiss any promotion goodbye. I've come too far to throw in the towel. Roll with the punches, and fight them every step of the way. Make NASA pull me back down to Earth. *Now do you see why you can't get close to anyone, Judy?* I forced a smile.

"I think I can live with that. But I'd rather go EVA now while the press isn't right on top of us. It's too confusing with all the people around. We can tour the laboratory and crew quarters after the interview."

"Great!" Lance's eyes seemed to dance with excitement.

Pallin squeezed my shoulder. "I'll call some techs to help you get ready." As he shot off, I was left alone with Lance. The football player lifted his brows.

"Sorry for the inconvenience."

I waved him off. "Dr. Pallin said he'd take full responsibility. He okays the rules, so it's no problem."

Lance nodded as if thinking to himself. "If you're sure. After all, it must be tough being in charge of the station and being overruled by someone from Earth."

I stopped, startled that he'd be capable of making such an observation. Especially after watching him in action a few minutes ago. I nodded toward the airlock at the rear of the chamber. "Come on, we'll get the tethers before the techs get here."

We pushed off to the *Heinlein*'s nearest airlock. Lance stood quietly by as I rummaged through the netting that bound up our EVA supplies. That's the nice thing about zero-gee storage—all you have to do is tie it up, and that saves on lockers. I pulled out a coil of tether and an EVA kit and made a quick inventory of the kit: sheathed scalpel, suit patching equipment, netting and the usual assortment of tools.

The techs arrived, and as they checked Lance's suit, Dr. Pallin clucked over him like a mother hen. As I prepped for the EVA, I quietly studied the young man. *He's at least ten years younger than I,* I thought, *and besides being the heartthrob of every woman this side of Mars, he's also the most eligible bachelor. How could someone be so friggin' perfect?* A song ran though my head "*. . . if I only had a brain. . . .*"

I caught my thoughts drifting, wondering if perhaps I'd been too curt with him. The fourteen years I'd spent chasing after a Ph.D. and fighting for this job made the four years he'd played pro football look insignificant—some peo-

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ple were just born lucky, vaulting to the top of their profession, while others had to struggle. He had it so easy.

Dr. Pallin jerked me out of my thoughts. "We're ready, Judy."

"Right." I tugged on the tether. A line made of tape-wrapped carbon phenolic would insure we wouldn't float apart. That line would be tied to another tether, fastened to the *Heinlein*. The jaunt outside should be a piece of cake.

In a suit at least twenty percent larger than the standard issue, Lance looked like an oversized robot. He had his helmet on and was under pressure, ready to go. The orange "7" sprayed on the suit glowed in the station lights.

Before putting on my helmet, I keyed on my mike. "Mr. Wasserman, can you hear me?"

"Yes, very well." Heavy breathing came over the channel. It sounded as if Lance was having a hard time.

"Are you all right?"

"Just getting excited. I guess I have butterflies. It feels like I'm heading into a game."

I continued talking as I put on my helmet. "This is a little different from a football game, Mr. Wasserman. Surely you don't get butterflies anymore, not with your experience." The others were cut off from our conversation once my helmet was secure.

Lance was silent. He came back slowly, "I have to try hard at everything I do, Dr. Roviola. Believe it or not, I've got to work extra hard, especially for a game. . . . it's great being a pro quarterback, but the pressure to perform can wear you down. I guess it's knowing that I've got to perform, as well as keeping from being killed out there on the field, that causes the butterflies. Sometimes I wonder if it's worth it."

Surprised, I nodded to myself. "Yeah, I know what you mean. Even my job gets old, especially when you have to always prove yourself." So here I stay, I thought, fighting for the chance to get back to Earth. Sometimes I think it might be nice to lead a normal life. . . .

Pallin squeezed into the airlock with us. There was just enough room for two people suited up; the techs who would help me with Lance's EVA were outside the airlock, helping each other strap on their maneuvering units. Pallin wore a headset and plugged it into the bulkhead.

"Lance, just follow Judy's lead. You've got air for two hours, but you'll only be out fifteen minutes. Remember not to make any sudden movements. If you get disoriented, just close your eyes and Judy will help you get back in. And watch it when you move out of the airlock—it will look like you are stepping out of a window three hundred miles high. Any questions?" He waited a moment, then said, "I'm heading up to the command compartment. We'll monitor your EVA from there and get it on film."

Giving Lance a slap on the suit, Pallin shot me a "thumbs up" and pushed out of the airlock, swinging the door shut as he left. I keyed my mike.

"Once we decompress you may hear a slight hissing sound. Don't worry—it's your suit outgassing to the vacuum. That means the gas molecules attached to your suit will fly out into space."

"I'm surprised you can hear the negative adsorption."

I stopped, startled that he'd be fa-

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miliar with chemistry. I said slowly, "It's because we undergo a fairly rapid decompression. It takes a little over a minute to vent the air."

Silence, then, "I guess it makes sense that you can hear the outgassing. The diffusion pumps I ran took hours to get down to a good vacuum."

"Where'd you do that?"

"Undergraduate physics lab." He was quiet for a moment. "I'd love to go to grad school if I could ever find the time."

I pressed my lips together. I'd heard of football players who took bar exams, and others who even became doctors, so I shouldn't be surprised. I felt suddenly bad at talking down to him earlier. And more importantly, he had *listened* to me.

Dr. Pallin interrupted my thoughts: "We're ready up here, Judy. The cameras are trained on the airlock. Any time you're ready."

I grinned at Lance. "He'll turn anything into a circus. Ready?"

Lance's breathing quickened. "Let's do it."

I scanned the inner door, making sure it was secure, but didn't spend much time on it. After all, as soon as the outer door was open, with the *Heinlein*'s air pressure against the inner lock—all 500,000 pounds of it—*nothing* could open the door. I punched in a decompress time of one minute. Seconds later, wind from the air venting into space swept past us. The outer lock swung open wide.

I looked out on deep blackness that never ended, sprinkled with stars. My chest started hurting when I realized I'd been holding my breath. After a year it still hit me like this to go EVA; the observation port was too constricting to show a sight like this. Lance must be living in heaven by now. It was so serene out here, and I felt suddenly closer to Lance; he's so different than what I'd stereotyped him.

Quietly watching him, I felt my face grow flush. *It's happening again*, I thought. I could really get us in trouble out here if I don't pay attention, and instead of caking on makeup, the stakes are a hell of a lot higher. Feeling suddenly foolish, I pushed him from my mind and ran over the EVA procedure.

I let him gawk for a minute and then spoke quietly. "Let's move outside. I'll secure the tether so you can pull up." I drifted out the opening and pushed to a strut just above the airlock. I wrapped part of the tether around the fixture. "Ready, Mr. Wasserman? We've got to clear the airlock so the techs can join us."

"Be right there." The sound of his breathing quickened as he came into view. Pulling himself hand over hand, he moved up the tether to a spot just below me. The Earth sat overhead in blue-green brilliance, blazing against the ocean of stars. To the right, the *Discovery* floated not twenty meters away.

Pallin came over the radio. "We've got you in view. Lance, wave to the cameras."

I clicked my mike twice. "Roger that. And the airlock's clear."

Lance pulled away from gaping at Earth and searched the *Heinlein* for the press corps. I floated out and tried to point out the command chamber, fifty meters away.

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"They're over to your left."

Lance started floating down. He reached for the tether when I noticed him stretching out with his leg, trying to find a foothold. His foot drifted into the airlock, just missing the giant hinge.

I kicked my mike with my chin and screamed. "Lance—*pull up!*"

The airlock door slowly swung shut. Lance's leg jerked up, but it was still inside the airlock as the door continued to close.

"Emergency hold, *Heinlein*. Freeze the airlock door, *now*." I flipped over and shinnied down the tether to Lance. "Pull your leg out."

The airlock door stopped moving, having just missed crushing Lance's knee. His leg appeared to be stuck in the hinge, right where the airlock door met the space station. Adrenaline pumped through my veins, kicking my system into high gear.

"Lance, are you all right?" Even though he still held the tether, he didn't move from his position.

"My leg's caught." He came back simply.

"Just a second." Moving along the strut, I climbed from the structure to the airlock door.

"Judy, what the hell is going on out there?"

"Stand by, I'm checking it out—"

"Judy, what happened? Is Lance all right?"

I reached the bottom of the airlock and peered in.

"Judy, answer me, dammit. What the—"

I controlled my voice. "I'll get back to you in a moment. Let me find out what the problem is. Just don't touch those airlock controls." The outer edge of the door was open three feet, just enough room to squeeze in.

His leg was caught in the closing mechanism, where the door was connected to the airlock. I kicked up and floated to the top of the chamber. Everything looked OK, but I didn't dare try to pry him loose.

I said, "Lance, are you all right?"

He came back immediately. "Yeah. I just can't move."

"Does it hurt?"

He was quiet. Then, "A little."

Great. To a football player a "little hurt" could mean anything from a scratch to a broken bone. I ran my gloved hand over his leg. The suit was pinched right below the knee. I keyed my mike.

"Dr. Pallin, Lance's leg is caught on the hinge—"

"Get him out of there. What are you waiting for?!"

"*Quiet!* Now give me some time—or do you want him to die?" Pallin shut up. Only Lance's breathing came over my suit radio. I waited a moment, then took a deep breath. "I don't want to pry him loose. There's a chance the suit will rip." *And his blood would start boiling three minutes after the air rushes out,* I thought. *One dead quarterback.*

I closed my eyes, racing through the options. There's more than enough help, just on the other side of the door. If we could only get loose. I fumbled in my pouch and pulled out a press-on patch from the EVA kit. Ten centimeters across, it wouldn't help if the rip was a big one. And from the amount of material caught in the hinge, this rip was playing with the big boys.

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I wet my lips. "Can you get me a rescue bubble?"

Pallin's voice came back, quick and low. "We've experienced some difficulty, but we've got three additional teams suiting up. We estimate it will take less than ten minutes to get to you."

I inspected the hinge. Was there any way to cut through it? The scalpel in the EVA kit might go through the aluminum mechanism—but could the outer airlock door function with one hinge gone? I doubt it. No, that's not it.

I didn't like it, but I made up my mind. It was the only way to help him.

"Dr. Pallin, get a bubble out here. Once we get it over Lance, you can open the door to release him. He shouldn't be in vacuum for more than thirty seconds."

A moment passed. "Why can't you release him now and get him into the airlock?"

I chewed on my lip. "Even at the max in-flow rate, it will take two minutes to pressurize the airlock—that's a huge volume to fill with air. And if it's a big rip, he'll last less than three minutes before his blood starts boiling. That's cutting it too close."

Silence met my observation. Pallin finally came back. "We'll have the bubble to you in ten minutes."

I squeezed out of the airlock and climbed up to Lance. I didn't want to use the tether—any motion might cause his suit to rip. I pulled up close to his helmet.

"Can you hold on?"

"Ten minutes? Sure."

I reached out and patted his arm. I couldn't see his face through the helmet. His head was in the strut's shadow, away from the Sun and Earth light.

"Lance," I said, "be sure to tell me if you start to hurt."

"I'm all right, just uncomfortable."

I closed my eyes. It took an effort, because I was still pumped up from the adrenaline. This wasn't going to be easy. . . .

"Dr. Roviola?"

"Yes?"

"The outgassing. How long is that supposed to last?"

"Less than a minute. Why?"

Lance took a moment to answer. "That's what I thought. I can't remember if it ever stopped or not. But I hear something like it now."

I scrambled around to study his leg. I still couldn't see a tear in the suit. "You do?" A cold chill swept over me. "Lance, what's your suit pressure? Quick."

He took a moment to answer. "Uh, five point three psi."

Pallin broke in. "Judy, what's going on?"

Holy Mother! His pressure is half what it should be. I tried to keep my voice steady. "How about your air reserve?"

"Judy, what in the hell—"

"Shut up, Pallin. Lance, answer me. *Now.*"

The answer came back slowly. "My air reserve says oh point one is left in the tank."

That's it, I thought. One tenth a tank left—normally twelve minutes' worth—after his suit's only been pressurized fifteen minutes. He's got a leak. And at that rate, he's got three minutes of air left.

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I wet my lips. "Lance, listen to me very carefully. Your suit is trying to maintain pressure, but you've got a leak. You don't have much air in your tanks."

"That's what I thought." His voice was solid, but low.

I've got to get him inside, I thought. *But how?* I racked my brain—there's got to be a way. But if I release him, he'll lose air like crazy. Maybe even an explosive decompression. And with the way these suits are built, I couldn't even switch air tanks with him. Why hadn't I been more firm with Pallin?

I keyed my mike. "Dr. Pallin, any chance of getting out here quicker?"

Pallin's voice sounded strained. "We're working on it, Judy. Don't count on it though."

"Stand by, then. We have a situation here."

I took a deep breath to calm myself. *What can I do?* There had to be something. I couldn't risk ripping his suit—not when it takes two minutes to pressure the airlock, and not to mention the time getting him inside the lock. He hasn't got a chance. *Less than three minutes of air left!*

Lance put a hand out on the tether.

Come on, think. This wouldn't have happened if I'd kept him closer on the tether, I thought. If I'd only—

The tether!

I fumbled in the EVA kit and withdrew the scalpel. "Lance, what's your air reserve showing?"

"Oh point oh five."

Ninety seconds. Steadying myself on the strut, I unsheathed the scalpel, taking care to hold it by the mylar end. I pulled a length of tether and sliced it—it went through the carbon phenolic wrap like a sword through air.

And I was now untied from the *Heinlein* and Lance. I tried not to think about it as I sliced off a meter length of tether.

This is going to be tricky, I thought. I wrapped my legs around the strut and hung upside down, relative to Lance. Looping the tether twice around his upper leg, I stopped and placed a hand on Lance's chest.

"Lance, I'm putting a tourniquet above your knee. When it's tight, I'll have Pallin open the airlock. If your suit rips any more, I don't know how long the tourniquet will hold, but it should keep all your air from escaping and will buy you time to get to the airlock."

"I've been listening. Let's get it over with."

"Right." I searched his helmet but still couldn't see him. His breathing came quicker than ever across the radio. Bending down, I yanked the loop around his leg, pulling it taut. I grunted; it was as tight as it was going to get. Thank God for astronaut training.

I drew in a deep breath. "*Heinlein,* open the airlock door."

"Judy, are you sure—?"

"Open it!"

"Roger that." The door slowly rotated even as Pallin spoke.

I didn't hear the pop, but Lance's suit relaxed, depressurizing, as the fabric tore.

Lance grunted. "I'm . . . free." His breathing raced as he tried to push up.

I swung an arm under his shoulder. He moved up easily, but his inertia caused me to rotate back against the *Heinlein.* "Lance, the airlock. Can you make it?"

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Only the sound of his panting came over the radio.

I pulled his body by grabbing onto the tether, still wrapped around his waist. Kicking out, I managed to push both of us away from the *Heinlein*. We slowly spun out until we reached the end of the tether, bounced and started back. We were moving too slow. *This is where the fun starts,* I thought. I held onto Lance by his arm. Using my free hand, I started inching along the tether, toward the airlock. At first we barely moved, but as we built up speed, the airlock grew closer and closer.

I rotated Lance, turning him feet first as we drifted to the station. Something floated past my helmet—powdery, it looked like dried blood, leaking from Lance's suit. I forced myself not to think about the bubbling flesh.

It felt like we were moving in slow motion as Lance spun around me. As we reached the station, Lance's leg hit the airlock, wheeling him around. I kicked back, trying to find a foothold. I screamed, "Close the door!" and shoved him in.

The motion sent me flying backwards. Floating away, I clawed at the door. I stretched my fingers. "*No!*" The airlock door kept moving away from me until it closed shut.

Don't panic, I thought. *There's got to be something. . . .*

I kicked my air pressure down to five psi and tried to keep calm. Anything to conserve air—they'll have someone out to get me. I tried to control my breathing. . . .

That's when I drifted by the crew quarters, five meters away. Spinning slowly, the stenciled letters *Robert A Heinlein* receded away from me.

I started sobbing, closing my eyes to the stars and Earth as I floated from the station.

The voice faded in and out. . . .

" . . . we caught up to you 500 meters away. If the techs hadn't had their maneuvering units on . . . " Pallin's voice wavered. "They've got you pretty well doped up. You're still in shock."

I coughed and tried to sit up. They had me tied to the bed, my arms and legs secured. "I'll be all right."

"No." Pallin said firmly. He patted my hand. "You gave us one scare already. Besides, you're a media celebrity. The whole rescue was taped and ready for broadcast."

Rescue—and it hit me why I was out there in the first place. *Lance! Oh, God, please—just when there was finally someone who listened. . . .*

I strained at the straps again. "Lance, how is he?!"

Pallin pressed his lips together and shot a glance to his left. Following his gaze, I saw Lance beside me. Tubes ran into his nose, mouth, and arm. A motor whirred in the background, keeping up the IV's back pressure. I tried to reach out and touch him, but my arms couldn't move.

Pallin spoke softly. "Like I said earlier, he's a big boy. His leg was . . . well, it wasn't pretty . . . and he lost a lot of blood." He paused. "They'll have to do some reconstructive surgery." Pallin shook his head. "That's a shame. He had a great career ahead of him."

He paused for a moment. "NASA's

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sending you back on the *Discovery* with him; you've got a well-deserved R&R coming up. They'll move you out within the hour." He lowered his voice. "And from what I hear, NASA's ready to make you an upper management offer at Johnson. Judy, I'm sorry they're pulling you off the *Heinlein*, but they've got big plans for you dirtside."

Lance coughed, expelling fluid. A nurse dabbed at the spinning bubbles. The spasm over, he turned his head and looked at me. He didn't speak, but his eyes searched mine.

I relaxed back onto the bed, keeping my eyes riveted to his. *Earth*, I thought. *I'm finally going back. And to something where I won't have to keep up a facade.*

I shook my head and thought about Lance's doubts and interests. And mine.

I'm not *that* much older than him.

And if he was willing to go to grad school in Houston, maybe something could happen between us. I whispered, "I still think he's got a great career ahead of him." ■

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USEFUL LIFE

Kevin O'Donnell, Jr.

There are events which people expect to happen, if they happen at all, with a great deal of fanfare. The reality may be quite different.

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The phone rang. Its RANDOM light glowed, so he said, "Friendly Ear."

"Good morning, Friendly Ear." Her cultured voice hinted at New England aristocracy—Smith College, perhaps, and summers in Maine. Tennis whites bright enough to blind and dinner at the yacht club.

"Good morning." Wheeling to the next cactus bench, which sagged beneath two dozen containers of *Opuntia microdasys*—bunny ears, always a good seller—he scanned the rows of plants. Cottony wisps clung to one round pad of a very nice specimen. He hoisted the six-inch clay pot and tilted it to the diffused light streaming through the greenhouse panels overhead. Mealy bug. Damn. "Ma'am? Can I help you?"

"Should I kill myself?"

"No." Ah, why did she have to ask so politely? Now she'd linger in memory like all the other considerate ones, narrating his nightmares with unforgettable courtesy. He set the pot back on the bench. "No, you shouldn't, ma'am."

"Why?" Undercurrents of stress and fear, but no hysteria, no panic. Nearly-normal intonation, not the dead flatness of those so sunk in despair that only death offered hope. "What do you know about me?"

"That you have an enchanting voice and a good education." After dipping a cotton swab in rubbing alcohol, he leaned forward to dab it on the bugs. The alcohol would dehydrate them. "That you're a woman of strong character, and that you're talking to me. That's all."

"Then how do you know I shouldn't?"

"Because it's irrevocable. Because if it's right, you can do it any time, but if it's wrong, you can't ever take it back." He rotated the pot once. All gone. Good. He dropped the used swab into the paper bag clipped to the side of his wheelchair. If only he could save people as easily. Or care as little when he failed. "Life's better than death, honest. No matter how it may seem to you right now. God's honest truth — things will get better."

"Why did you volunteer?"

He relaxed. Anyone actually curious about another human being still wanted to live, whether she knew it yet or not. He could talk this one down. "Do you mean for Friendly Ear duty?"

"Yes. Are you one of those insufferably cheery and optimistic types the rest of us would like to strangle?"

A smile came to his lips; he let it into his voice. "More than a few of my acquaintances would enjoy strangling me, but it's doubtful that any of them would describe me as cheery and optimistic."

"Then why? I want to know. Please?"

Many of those who called just to talk asked that. He didn't mind answering, but he'd told the story so often that he feared it had become merely that: a story, rather than an ordeal he had survived. With each retelling, past pain and urgency grew more distant, more matter-of-fact. Someday he would discover that the emotions had dried up and blown away; that day, he would resign from the Friendly Ears. "Four years ago, the doctors told me they couldn't approve me for prosthetic legs after all, because the shrapnel had paralyzed me from the hips down and they couldn't get anything working again."

"Shrapnel? Were you in the war?"

"Yes, ma'am. In the hospital, they

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gave me a wristwatch with all the usual features and two really unique ones—gauges that display the pressure on the artificial sphincters implanted in my bladder and colon. They taught me how to read the gauges so that I'd know when to start looking around for a toilet, and how to open the valves between my legs so that I didn't get my hands dirty. They used the word 'lucky' a lot. As in, 'You know, soldier, you're lucky—most boys with wounds like these would have died.' "

"While you thought it was the dead ones who were lucky?"

"Exactly. So when they let me out, I got an ice pick, and crawled into a warm bath. The plan was to punch enough holes through the femoral artery on each leg so that it wouldn't take more than a few minutes to die. See, given no sensation below the hips at all, it wouldn't have hurt a bit. But how many holes to punch? I called a Friendly Ear. We talked for three, four hours. By the end of the call, he'd convinced me to wait one year. If life still sucked, I could do myself in with his blessings. At the end of the year, I looked around and decided things weren't so bad after all. Understand, they weren't *good*—they're still not—but they weren't so bad that death was preferable to life. This guy had me in his debt, but I couldn't pay him back. Friendly Ears are anonymous. So I joined hoping to do for others what he did for me."

She didn't say a word for a long time. He let silence fill the line while he wiped sweat from his forehead and inhaled the hot, dry air of his greenhouse.

"Friendly Ear?" she said at last.

"Yes, ma'am?"

"Are you tracing my call?"

"You know that's impossible."

"I know they *say* it's impossible, but what I need to know is the truth—are you?"

"No. When you dial 1-8000-A FRIEND, some very special software that the phone company wrote exclusively for us, takes over. It chooses a Friendly Ear at random and connects you without making any record of the call, internal or external. At this moment, Ma Bell's computers know that you're using your phone, and I'm using mine, but only one chip knows we're connected, and it won't tell the rest that we're talking to each other."

"Who else could we be talking to?"

"Ma'am, there are a hundred thousand Friendly Ears, and we each take a couple calls a day. There's four or five thousand calls going on right at this minute. Now, the computers might assume you're talking to a Friendly Ear and I'm talking to a new friend—if their programming lets them make that sort of assumption—but if they try to trace the call, the chip disconnects us and zeroes its memory. So don't worry."

"You're sure?"

"Yes, ma'am. Positive."

"Good." She paused for a few seconds. "I'm trapped here."

"That's a horrible feeling, isn't it?" He wheeled down the tiled path between the benches to the first tray of *Parodia*. "But how do you mean, trapped?"

"I mean I can't get away."

A familiar lament. Perhaps the most familiar of all. "You can't get away from what—a relationship? Your career?" Flowerbuds had swelled on four *Parodias* since Friday. He priced those

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pots and shifted them to the front row; his assistant would move them into the store tomorrow.

"The planet."

"Ah." Not so familiar. He straightened in his chair. The other *Parodia* trays could wait. "You mean this planet? The planet Earth?"

"Yes. I want to go home, but they haven't come back for me. It's been six years. They're not *coming* back. I'm going to die on an alien planet and I won't have a grave *loy* so why shouldn't I just go ahead and get it over with? It's not like anyone here will miss me."

He sighed, but softly enough, he hoped, that his earpiece mike did not pick up the sound. Not for the first time, he wished the mentally disturbed of the world would call the Psych line instead of the Friendly Ear line. "Could you explain some of that, please? It's a little new to me, you see, and—"

"You think I'm crazy, don't you?"

He took a deep breath. A strange high hum came down the telephone line and lodged inside his skull. He had never heard anything like it before. It filled his brain, blurred his vision, and shivered the bones in his neck.

She seemed to be saying something, but the hum either drowned out her words, or so disoriented him that he could not understand her. His own lips moved. Though he had no idea what he said, the hum stopped.

"Well? Do you think I'm crazy or not?"

He tried the deep breath again. This time, nothing happened. "You have a unique perspective on the world, but that doesn't mean there's anything wrong with you. Tell me—"

"Never mind. Thank you. Goodbye."

"No, wait!" he said, but she did not heed him. She hung up.

Defeated, he stabbed the disconnect button.

An hour later, the phone rang again. Since the RANDOM button did not light up, he expected a friend, or a supplier, or in the worse case, a creditor. "Pincushions Unlimited, Jess speaking."

"Hello, Jess. I wanted to apologize for breaking off so abruptly earlier this afternoon."

He stared at the phone set built into the arm of his chair. He opened his mouth. He closed it. He shook his head once and said, "How? How did you get this number?"

"Superior technology, Jess. Remember where I'm from?"

"Yes, but—"

"I thought you said you believed me." A teasing quality entered her voice. "Oh, Jess, now my feelings are hurt. Didn't you at least notice the buzzy sort of white noise in the middle of your mind?"

"That was you?"

"Yes—well, not me, personally, you understand, just my overrider. They issue them when we arrive. Very useful in unpleasant situations. Sometimes you just have to convince someone that he has to do what you want, not what he wants. So you tap it, think the command, and it's done. And afterward —well, you don't remember giving me your name and phone number, do you?"

"No. No, I don't." He swallowed hard as potential uses for such a device

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suggested themselves to him. "God, if that ever fell into the wrong hands—"

"It can't. It's implanted bio-electronics, keyed to one particular set of genes. Even if someone could cut it out without killing it, it wouldn't work for him. So don't worry. Besides, it's not all that powerful—it won't run for more than ten seconds at a time, and takes forty-eight hours to recharge." A near-giggle escaped her. "Rather like some men I know."

"Um . . . Um . . . You sound like you're in a better mood."

"Oh, I am!"

"Well, that's nice. What, um, what provoked it?"

"I've decided to accept your advice. I'll give life another month. May I still talk to you?"

"Sure! Yes, listen, I wanted to ask you, where is your home?"

"Are you an astronomer?"

"No."

"Then what difference would a name make?"

"None. Would you like to talk *about* your home? Why do you miss it so much? What does it have that Earth doesn't?"

"Two moons," she said, "a fresh-water lake the size of Texas, and winters so cold that all you can do is sleep until spring. I *belong* there, I fit in. I don't feel self-conscious there. I don't feel like a spy."

"Are you? Is that why you're here?"

"No," she said mournfully. "No, I'm just a tourist who missed her flight."

"There'll be another, won't there?"

"They promised to come back for me—they left a note—but they haven't. And there aren't any more flights. Not with a war going on."

"The war ended three years ago," he said softly, his eyes closed, the phantom ache rising in the legs he'd left in Buenos Aires.

"Not *your* war. *Ours*."

"Ah. So . . . so tourist flights are canceled for the duration?"

"Yes. Leaving me trapped here. Marooned."

"But when the war's over—"

"Who knows when that will be?"

"That's why it's good you've decided to wait. Because when the war is over, and they make the effort to return for you, if you aren't here—"

"I know," she said in a very small voice. "They'll feel cheated. Betrayed. But that's how I feel right now, don't you see?"

"Yes, of course. How else *could* you feel? But it's not their fault, is it?"

"Yes, it is! They waited for all the others—they could have waited another hour for me—but they didn't. They left early!"

"Because of the war?"

"Yes. That's what the note said, anyway. So there I was in the parking lot with all my luggage, scads of souvenirs, and absolutely no money."

"Parking lot?"

"It was the rendezvous point. The bus was supposed to take us to the ship."

"Uh-huh. So what did you do?"

"What could I do? I went into the diner and asked for a job."

"And got it?"

"I've been a waitress ever since. And I'm tired of it. My feet hurt, I'm always getting pinched, and the boss takes half

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my tips. If it weren't for the overrider . . . ''

''Why not look for another job?''

''Because I have to be here when the bus comes back, don't you see? Either here, or dead. If I'm dead, it doesn't matter, but if I'm not, and it comes back and I miss it again, then I'm stranded here forever and I'll go crazy, and I'd rather die than lose my mind.''

''So you have to live in the parking lot?''

''No, the bus will wait twenty-four hours. I just have to check once a day. But— Jess, I can't talk any more now. I'll call you back next month. Thank you. Goodbye.''

She hung up before he could say a word.

Five weeks later, the phone rang. ''Pincushions Unlimited, Jess speaking.''

''Hello, Jess. It's me.''

''Well, hello there, how are you?''

''I feel miserable, Jess. I gave it a month and five days extra, but it's not going to work, and they're not coming back for me, and—''

''Talk to me, huh?'' He wanted to stall her for a while, and keep her from doing something rash until he had cheered her up. If she could get past this moment of ultimate bleakness, she could do another month, or a year, or a lifetime. . . .

''I just borrowed an ice pick from the diner's kitchen. I've drawn a nice, warm bubble bath, and I've taken off my clothes. I've been thinking of you ever since I made up my mind, so I decided to call and thank you for your help.''

Weary desolation welled up in him. ''No, listen, you can't—that's not fair—my God, I tried to talk you *out* of it, and now you're going to use the same method— Don't you know how much it's going to hurt? Don't you know how awful I'm going to feel? Lady, please, my nightmares already have casts of thousands, please don't add another voice to them.''

She paused for a few seconds. ''What is 'Pincushions Unlimited'?''

''My greenhouse. We raise cacti and succulents. Mostly cacti.''

''Why?''

''Because cacti are relatively catproof. They don't mind neglect, and they're beautiful when they bloom.''

''Like *loy*.'' A note of wistfulness sounded.

''You used that word before.''

''They're similar to cacti—I mean, they're green and spiky—they're very short, but they grow sideways for oh, yards and yards. We plant them on our graves. I think originally it was to keep the wild animals from digging up the bodies, but now it's a tradition. Does it excite you to be talking to a woman who's told you she's naked?''

''It might,'' he said dryly, ''if I had anything to be excited with.''

''Nothing?''

''They offered to install an 'appliance,' but it seemed, um, unlikely that it would ever see any use. So . . . ''

''Poor Jess.''

''It could be worse.''

''How?''

''I could have an ice pick in my hand.''

''Touché,'' she said softly.

''Nothing personal.''

''Oh, of course not.''

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"Ah . . . say, how do you pass for a native? Make-up and costume?"

"Oh, no! The travel agency maintains a stable of hosts. We use them like tour guides. I picked one from the catalog, and they poured me into it when I got here."

" 'Host'?" The skin at the back of his neck prickled. A new horror would haunt his nightmares, now. "What do you mean, 'host'?"

"Oh, don't worry! These are— I'm sure you're familiar with the tabloid stories about people being kidnapped by UFOs?"

"Uh-huh."

"Well, some of them, at least, are true. When the travel agency needs to expand its stable, or to replace an obsolete host, then it captures someone —non-violently of course—takes cell samples, and records the brain on hologram. It uses the cell samples to grow the guide in a tank. At the same time, some very sophisticated programs edit out of the brain hologram all details of a personal nature without in any way affecting the tourist's ability to get along in the culture. Once the host reaches the appropriate maturity, they implant the background knowledge and skills. When the guide is rented, they pour the tourist's being in on top. After the trip is over, they pour the tourist's being out, erase the tourist's personal memories from the brain, and then stable the host until someone else rents it. It's really very simple."

He suppressed a shudder. "Where do they, um, keep the hosts when they're not, um, working?"

"Oh, I couldn't tell you that."

"OK. Uh-huh. What happens to an 'obsolete host'?"

"I don't know. It's not in the brochure."

"No." He rubbed his eyes. "No, it wouldn't be."

"Are you angry with me?"

"Ah . . . probably more at your system than at you. Although, now, you know, it's not suicide you're talking—it's murder. God, that body's kept you alive here, don't you feel any responsibility—"

"Wait."

A clack came through his earpiece; he presumed she had just set her telephone down. Something rasped—a window opening? Then a human squeal of delight and her breathless voice: "Jess! The bus! It's here! Oh my God, oh thank you, Jess! Good-bye!"

The line clicked. After a few seconds a dial tone burred softly.

The next month, a woman came into the greenhouse and approached him. Tall and middle-aged, she carried herself like an executive, or an aristocrat. Streaks of grey put character into her light brown hair. She had laugh lines around her mouth, experience in her eyes, and a discreet, flesh-colored bandage just below her left ear. "Jess? I'm Amanda Green," she said in the WASP-ish voice of moneyed New England. She held out her hand.

He recognized the voice at once, and stared at her hand for a long moment before finally taking it. At least she had a firm grip. "What can I do for you?"

"I'm looking for work. A former customer recommended you." She withdrew an envelope from her purse and

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handed it to him. "My resumé. I was a tour guide for twenty years, and a waitress for six. Both jobs require an ability to get along with people, a skill I'm sure would come in useful in your retail operation. And the fact that I stayed in each job as long as I did shows that I don't give up easily. Why not give me a try?"

He tapped the unopened envelope against the back of his left hand. He did not really want to ask the next question, but he had to. "Why did you quit as a tour guide?"

"Oh, I didn't quit." She smiled ruefully. "They're a foreign firm, and they discontinued American operations during the war. That's why I became a waitress." She shrugged. "Just as well, actually. Except between assignments, I never had a life I could call my own."

He handed the envelope back to her.

She took it hesitantly, the first strains of a frown pulling her eyebrows together.

"There's no openings out front," he said. "Besides, I doubt if you know your cacti well enough to work the retail store."

"But Jess, I can learn—"

"And you will. Back here in the greenhouse. Wear comfortable shoes and clothes you don't mind getting dirty. Be here at six."

"Thank you." She shook his hand and walked away.

He watched her go, and wondered if either of them would ever speak of the truth to the other—or if either would ever recognize the truth if the other did speak it.

He thought he might have nightmares about that. ■

●We trained hard . . . but it seemed that every time we were beginning to form up into teams we would be reorganized. I was to learn later in life that we tend to meet any new situation by reorganizing: and a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency and demoralization.

Petronius Arbiter, 210 B.C.
Submitted by John Hradsky

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THE MAN WHO FUNDED THE MOON
Alexis A. Gilliland
In politics, the shortest distance between two points is *seldom* a straight line!
William R. Warren, Jr.

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Chapter One

"It's an ongoing process," said Morrie Greenbaum. "First we shape our institutions, and then they shape us." Greenbaum had been a patent attorney with a drinking problem who was now a registered lobbyist for the Aerospace Industries Association. "Nobody likes to be shaped and who could blame them?" An attentive waiter refilled his coffee cup; the lobbyist was one of "L'Aigle D'Or's" regular customers and a heavy tipper. "So the thing to do is shape our institutions first."

Congressman Werner Voss studied the understated ivory and gold leaf decor, the flash of the cut crystal chandeliers, and wondered who *this* institution was supposedly bending out of shape. "That won't necessarily be an improvement," he said, mindful of his first-hand experience with reform politics.

"It has to be," replied Greenbaum. "The thing that shapes our institutions is technological change. Progress with a capital P. Who could be against it?"

"Anybody walking the plank," said Voss. "Anybody who loves the old ways. Maybe even the pillars of the institutions you are so blithely reshaping."

The strikingly handsome blonde put her hand on Voss'. "Not when you're the one doing the reshaping, Werner."

One of the perks of office, thought Voss resignedly, she wants to check out the old pillar. "Who pays for all this new technology?"

"Technology pays for itself," said the lobbyist.

Voss shook his head. "No. That's like saying the arms race pays for itself. You want to go in all directions at once and it can't be done. The big telescope is state-of-the-art technology, but it will be the Japanese building it instead of us because we haven't got the money."

"Well hell, Werner," laughed Greenbaum, "let 'em have it! The technology that drives the arms race is what makes this country great. Telescopes are toys!"

A shrug that might have expressed disagreement. "I thought it was the arms race that drove technology," said Voss.

"It goes both ways," conceded Greenbaum. "And also, there isn't just one technology but a whole gang of them. The hard-shell Baptists won't like it, but arms races are the act of evolution going on right before your eyes. 'Progress' you could call it if you think the Chamber of Commerce doesn't like secular humanism." A pause. "With a capital P, of course."

"Specular humanism is a dirty word," said the blonde, as the waiter cleared the dessert dishes.

Werner Voss smiled at her slip of the tongue. "Specular humanism is when you look in the mirror and wonder what sort of gorilla is looking back at you."

Greenbaum laughed, a hearty practiced laugh that would come just as easily whether the joke was funny or not. "That's rich," he said, "I'll have to remember that; specular humanism."

"We were talking arms races," said Voss.

"Right. This arms race is technology and technology is progress, and progress is what made this country great! In two years we'll be employing up to 1,200 people in your district. Assuming we get the funding."

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The congressman nodded. He didn't think the proposal was good for his country, and even his district wasn't coming off too well. Some of those 1,200 were temporary construction jobs, and most of the rest were going to be out of state engineers and computer people. The blonde leaned over and blew softly in his ear.

Representative Voss looked up from his mahogany rolltop desk. "You're back," he said, and having stated the obvious, turned his swivel chair away from the desk and nodded. His aide pulled up the indicated chair and sat down without formal invitation.

"I'm back," he conceded. "The airline lost my luggage again, but the report I have with me." He took a three and one-half inch diskette from his shirt pocket and laid it on the desk.

"That's it?"

"Plus hard copies," the aide patted his briefcase, "and backup copies." There was a pause. "The GAO gave me everything I asked for. The lab . . ." A shrug and silence.

Voss picked up the diskette and turned it over in his pudgy fingers. "They promised to be fully cooperative, the lab."

"They weren't noncooperative, Mister Voss. Exactly."

"Something's going on," said the congressman, sighing. A safe enough statement, something was *always* going on. "Well, that's why you went, of course." He held up the diskette. "What ought I to know here, Mario?"

"How shall I put this," mused his aide. "When I was in high school I read a science fiction book about the warrior scientists of North Polar Jupiter and they were hell on wheels. OK? They were evil, but they did great science and they went down fighting, trying to advance the state of the art right up till the moment our heroes blew them away." He sat back in his chair and crossed his legs. "The lab, I hate to tell you, ain't got any warrior scientists."

"Warriors are out," said Voss. "Warriors make the chain of command uneasy."

"The Israelis have warriors."

"Israel is closer to the margin," the congressman replied. "The U.S. . . ." he shrugged. "So the lab doesn't have any warrior scientists. There are places where you don't want warriors, such as the Joint Chiefs of Staff."

Mario polished his glasses with a handkerchief. "Right," he said at last, "but at the lab they aren't scientists, either."

"Come on," Voss protested. "We have a Nobel prize winner heading up the place."

"Yeah, yeah. They have the credentials, no doubt about it, but they aren't warriors and they aren't *doing* science. At least not at the office."

"Mario, this is not something I want to hear!"

"Mister Voss, this is what you sent me to find out. The report doesn't say so in plain language, but look at the table on the citations the lab used in their reports. What it shows is the same people citing their old work over and over again as the justification for spending billions and billions of dollars to keep on blowing holes under the Nevada testing ground." He took a deep breath. "And the old work isn't worth shit!"

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A pudgy hand slapped the desk. "What?!"

"Read the report! What it says is softened way wa-ay down, but 'conceptually flawed' means they started off with a dumb idea; 'tendentious arguments' means they worked backwards from the conclusion they had to have to get more funding; and 'technical infelicities' means that the goddamned tests were so badly done that the lab couldn't get any useful data out of them anyway!" Mario took a deep breath. "Even assuming that any data they *might* have gotten would be useful. Sir."

Werner Voss smoothed the hair over his bald spot. "The lab's work on developing the X-ray laser is crucial to the Strategic Defense Initiative. What are you telling me?"

"What do you think I'm telling you, sir? After spending however many billions of dollars they could lay their hands on, the lab hasn't been able to take the sucker from theory to practice!"

"But the classified reports?"

"They started off by having a GS-9 analyst vet them so they weren't telling us any actual lies. So technically they're clean. And then the lab's PR people sat down with friendly Senate staffers to delete all the modifiers and disclaimers so people wouldn't get confused. One of the people I interviewed was the GS-9."

There was a long pause. "The SDI appropriation has a nut of 185 billion current dollars going out over the next ten years, Mario. A lot of which is going to be spent in my district."

"Yes sir. What did you tell that fellow who was in here the other day lobbying for a big new telescope?"

The congressman scowled. "The money isn't there."

"It was a really neat telescope, Mister Voss."

A sigh. "Maybe. But we have to prioritize our spending."

"Pouring 185 billion down the tubes is OK as long as some of the tubes are in your district?"

Werner Voss shook his head. "So maybe it isn't OK, but there are some things that just have to be done, and the SDI looks like it could be one of them."

"Eh, maybe, maybe not." Mario thought it over for a moment. "Why did you send me to check out the lab, then?"

There was a pause. "Religious reasons."

One of Mario's eyebrows went up. "Say what?"

Voss shrugged and spread his hands. "You do what you have to, sure. But I still need to know what the facts are, what's right."

After a family dinner in their modest Washington home, Representative Voss retired to his study with the men as his wife and two daughters gathered in the kitchen. The men in this case were his son-in-law, Sheldon, and Sheldon's visiting maternal uncle, Dr. Emiliano Chavez.

The study was a square room over the one-car garage on ground level, with a computer, two telephones, an answering machine, a fax machine, and a small copier jammed onto a worn oak desk, filing cabinets piled high with stuff, a table covered with books and periodi-

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cals, a credenza with a small TV, a brown leather sofa, and assorted chairs. The uninsulated walls had been paneled and were in any event covered with autographed pictures and citations. Sheldon picked up the stainless steel thermos on the credenza and poured himself a short cup of coffee. He then took the bottle beside it and added a long shot of Cointreau. He thought his father-in-law was a decent enough sort, but totally corrupted by the system he served. Safe areas of conversation were sports, weather, and the grandchildren. "Emiliano's right, you know," he said easily, "armies are obsolete."

"Hey, Shelly," replied his uncle, "you sure know how to tie knots in the nuances." He put his cup and saucer on the credenza. "What the argument was about is the meaning of technology as it applies to human affairs. What I *said* was that the whole historical record is framed between the invention of agriculture and the invention of nuclear arms."

Werner Voss sat back in his chair, content to let someone else be annoyed with Sheldon for a change. "You *don't* think nuclear arms have made armies obsolete, Doctor Chavez?"

"Call me Emiliano, Werner, it's the American way," said Dr. Chavez, rubbing his chin. "Obsolete is maybe the wrong word. See, it took a long time to invent agriculture (and we're still inventing it, as your friends on the Agricultural Committee will testify) and then it took a long time to invent cities and the armies that went with them." He eased himself into the red wingback chair. "And maybe they *weren't* invented but were only the unintended consequences of the invention of agriculture. You could make a pretty good case for that if you wanted."

He dances around the point very smoothly, thought Voss with a certain professional appreciation. "Let's stick to those 'obsolete' armies, Emiliano," he said. "What might the right word be, do you think?"

"One could make a case for obsolete, I suppose," replied Dr. Chavez. "Start with Shakespeare: 'Othello's occupation's gone.' Is Othello obsolete?"

"No, only unemployed after peace broke out. Venice will always need an army, right?"

Chavez grinned, showing uneven white teeth. "Shakespeare's Venice will, anyway. But always? Always is a long time. Does Venice need an army today?"

Werner Voss shook his head. "Not a Venetian army. But that's because she got together with the other Italian city-states to become Italy. Venice needs the Italian army, and certainly Italy needs an army."

"Without nuclear weapons?"

"Without nuclear weapons," agreed Voss.

"Well, then, the Italian army is obsolete, right? Against the French it would have no chance."

"The two countries are allies, Emiliano. They aren't going to war with each other."

"France and Italy are neighbors. Going to war with your neighbors is traditional, neighbors being so close to home and all. Can the Italian army protect Venice or any Italian city from nuclear destruction?"

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The congressman took a sip of coffee. "No," he conceded, "no, they can't."

"So the Italian army is obsolete, right? Forgive the question, I didn't mean to badger you. Of course it's obsolete." Dr. Chavez rubbed his chin. "But how about the French army?"

Pretty sneaky, thought Voss, the man is defining obsolescence by function instead of hardware. "They couldn't stop a determined attacker from bombing Paris, I suppose. That makes the French army obsolete, too?"

Emiliano mimed applause and smiled. "Bravo, sir! And Russia and America are hardly better off. The brave little Cessna that landed in Moscow's Red Square suggests that the Russian army, too, is more obsolete than anyone wants to admit."

"And America?" asked Sheldon maliciously. "Could a dope-crazed enemy deliver some of your carefully sanitized 'physics packages' disguised as tons of marijuana or cocaine to the central hearts of our great cities?"

"Perhaps," said Voss. "The threat appears somewhat unrealistic, however."

"Yes, yes," agreed Dr. Chavez rubbing his hands together. "It is necessary to defend against *realistic* threats, isn't it, Werner?"

I don't like his tone of voice, thought Voss. A little levity to fuzz the edge, here. "Close enough for government work."

"So your committee is contemplating spending a few hundred billion dollars on the SDI, to defend against the oh, *so* realistic threat of nuclear bombs carried in ballistic missiles, while dismantling the existing defenses against nuclear bombs carried in bombers. Soviet bombers are not a realistic threat, then?"

"Soviet bombers are not considered a first strike option."

"Ah. So you play by the rules and expect the Russians to play by the rules. also. But the fact is that even the American army cannot protect its cities, it can only avenge them."

Sheldon nodded in agreement. "Emiliano is right. And if the army can't protect the city, can't even *pretend* to protect the city, no matter how much money you spend equipping it, it's *obsolete*."

"Never fear, Shelly," said Voss. slipping into the familiar patronizing mode that annoyed his son-in-law so much, "our warrior scientists are working on the problem."

Chapter Two

"You Americans," said Doctor Sergei Ivanovich Zerkanjian, the First Secretary of the Soviet Embassy, "it is utterly patent that your government and your economy are driven by needs of the Military Industrial Complex, and yet you refuse to admit such a thing exists. I do not ask you to admit it at a cultural event such as this, but perhaps you could explain to me this curious lack of self knowledge."

Werner Voss gazed around the white marble atrium at the Kennedy Center. where a lavish buffet had drawn the usual collection of boring and important people. He took a sip of his third or fourth glass of wine and nodded. "An explanation exists," he said. "It is owing to my son-in-law Sheldon, the fool. that I became aware of it."

Zerkanjian displayed a cultivated

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Slavic ennui as he sipped his vodka martini. "You received enlightenment from a fool? How very interesting."

"One takes enlightenment where one finds it," replied the congressman. "In Sheldon's case, it is his unfortunate habit of taking a complex argument and focusing his entire attention on one word," he held up a forefinger, "one little word, so that the nuances get all knotted up, and eventually the argument vanishes in semantic static."

"You say your son-in-law is a fool," said the Russian, "but the men who run the American Government, they, surely, are not fools?"

He is too kind, thought Voss, oblivious to any possible ironic intent. Of course he *is* a diplomat. "The word, the label really, is 'Military Industrial Complex.' At a distance, say from the Kremlin, it looks like an entity. But as you get closer, say to Capitol Hill, it dissolves into a gaggle of institutions. As a shepherd, you complain to me of the wolf pack, and I know that we have one wolf, two foxes, three dingos, four coyotes, five feral dogs, and some pet doggies that slip out of the yard when the Moon is full. There is no wolf pack. Just these animals that get together to kill your sheep. But we can't talk to each other, because I don't want to hear what you are saying, and you are using a term that is not precisely correct."

Zerkanjian picked up a canapé and ate it in three tiny bites. "Fascinating," he said. "This what did you call it, 'gaggle' of institutions is stampeding towards a cliff and you do nothing to turn them aside?"

"Herds stampede," said Voss. "A gaggle," he sighed "a gaggle is of geese. I'm not sure what they'd do in a crisis. In classical Rome they saved the city from a night attack, once."

"So the ancient histories say," conceded the Russian. "But today, this Military Industrial Gaggle is pursuing any number of excruciatingly dangerous technologies in the belief that some day they will find a path that the USSR cannot follow, and that this path will lead to absolute security."

"I don't know if they believe that," said Voss, wondering if he had had too much to drink, "but that's what they tell Congress."

"So why don't you make them stop?"

Werner Voss shrugged. "My district would elect another congressman if I tried. Within limits the gaggle could be steered maybe, but you people on the other side of the fence always make faces and yell and set the sons of bitches stampeding off in the direction they always go." He turned the glass of wine in his hands. "One might call it the 'general' direction."

"I thought you said geese didn't stampede?" said Zerkanjian, nibbling another canapé. "No, forgive me. You make a point, and I see your point. Let me rephrase the question: the Military Industrial Gaggle, how could they be stopped . . . ? No, they can't be stopped, how could all that energy be harnessed to some socially constructive purpose?"

Werner Voss laughed so hard that several heads turned towards him. "Excuse me," he said wiping his eyes, and coughing. "You shouldn't have said 'socially constructive' when I was swallowing." How *could* all that energy be harnessed, he wondered. That mortal gush of arterial billions wasted search-

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ing for the weapon or the device or the advance that would somehow abolish the effects of atomic weapons that had made armies obsolete. The demented, idealistic search for the Holy Grail of absolute security that the military men couldn't bring themselves to give up. He took a deep breath.

"You Russians," said the congressman. "You study chess, while Americans play poker. You want to harness the Military Industrial whatever, there's a way to do it, but you'll be playing poker, you understand?"

"Of course," said the first secretary blandly. "What did you have in mind?"

"Make no small plans," replied Voss, listening to himself and wondering where his mouth was leading. "They have not the power to fire men's imagination." He took another sip of wine. "The Soviet Union needs to come up with a joint project that is *so* big. . . ." he hesitated, then took the plunge. "You need to come up with a joint project that will be so big that when the US goes for it, it will drain funding from the SDI forever!"

"A large project, indeed," conceded Zerkanjian. "But totally unrealistic, I'm afraid."

The congressman finished his drink. "Nobody said it would be easy," he pointed out, tapping the Russian's chest with his pudgy forefinger, "we're talking about the moral equivalent of war, here. You people come up with the project, and I will undertake to sell it on Capitol Hill."

In spite of himself, Sergei Ivanovich Zerkanjian was impressed. He reached into his jacket pocket and took out a spiral notebook and pencil. "Very well," he said, starting to write. "What are the parameters of this project?"

What would we need to spend, wondered Voss. He heard his mouth saying "Potentially, half a trillion dollars over the second ten years. Practically, it should start small and it should start feasible. The first step ought to involve no more than three or four shuttle loads into low Earth orbit." My God, he thought, listen to me. Whatever the hell am I talking about? Boris here is writing down every word.

"Very good," said the first secretary looking up from his notebook, "go on."

Boilerplate, thought Voss, that's the ticket. Give him a couple of paragraphs of legalistic pap to keep him happy. "To get something like this passed on the Hill it will need a cap, a maximum that can't be exceeded without mutual agreement, and a floor, a minimum that both sides are committed to spend."

The stubby pencil scribbled. "Yes, Mister Voss. Go on."

"And throw in a supporting research project or two." He put down his empty glass. "Chess. You know what a gambit is?"

"Of course. One sacrifices material to gain position."

Voss wasn't paying attention. "A gambit is from the Italian. In wrestling, one wrestler offers a leg, *da gamba,* so that if the other takes it, he gets thrown. Put something on the table to entice Americans into picking up the offer." He took a fresh glass of wine from a passing waiter. What else? "Oh, yes. Don't make the offer formally. Don't come to us at the summit and say that you have this great deal for the president. You want to get the Military In-

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dustrial Gaggle in harness, talk to them directly."

The first secretary looked up from his writing. "And where might one find this mythical entity?"

Werner Voss shrugged and took a sip of his California Beaujolais. Old Boris was acting very strange indeed, but the whole conversation had drifted so far from reality that it made no damn difference what he said. "You get a proposal worked up, bring it to my office. If I think it will fly, I'll show it to some people, OK?"

"It was very kind of you to see us on such short notice, Mister Voss," said Dr. Sergei Ivanovich Zerkanjian. "This is Colonel R. D. Kazdan, of the KGB's Technical Intelligence Division."

"Well," said Voss, totally baffled, "I'm pleased to meet you. This is Mister Mario Fuentes, my industrial liaison and general purpose expert."

They shook hands all around, Mario accepted the Russians's business cards, and Voss escorted them into his office. "Now, then," he said after they had seated themselves around the room, "what is it I can do for you?"

"You may not recall our conversation of a few months ago," said Sergei Ivanovich, "but you suggested the outlines of a program and promised to consider helping us implement it." He smiled faintly. "Make no small plans, you said."

"You also proposed a highly unorthodox method for their implementation," said Colonel Kazdan, fingering his thick black mustache. "Moscow is frankly dubious about getting any practical results, but there are nevertheless some interesting variations from the main line." He scowled. "It amused some people in high places, so we are here."

"Ultimately," said Zerkanjian expansively, "we look towards a jointly operated Lunar base engaged in mining and manufacturing to support other joint operations in space, and this is the line we will take in presenting the next summit to our own people. A sharing of technology made to open the frontiers of space to human. . . ." he hesitated and smiled, "habitation. Occupation has somehow acquired a military overtone."

"In part this will rely on the magnetic cannon—you call them mass drivers, I believe."

"Yes, Colonel," said Mario, "but that's classified material."

"An admirable sensitivity," said Kazdan. "However, this is for the somewhat more remote future when such numbers are declassified."

"Generally," said the diplomat, "we believe that we can inject slugs of matter, iron or aluminum or glass or whatnot, into a Lunar orbit with such extreme precision that a ship moving in a parallel orbit ten meters above or below will be able to sweep up these slugs with a collector's net."

"How much matter?" asked Voss.

Dr. Zerkanjian shrugged. "It depends. In principal we might achieve, oh, maybe a ton or more per hour."

"Well hell, wait a minute," said Voss, brushing back a strand of hair that had fallen across his face. "The whole thing depends on getting material into orbit cheaply enough to make it feasible.

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As you know, the shuttle is having problems in spite of the new engines."

"We, also, are having problems," conceded Kazdan. "So that what we are specifically proposing to lay on the table at the forthcoming summit is something far less grandiose, merely the proposal to fund half of a joint Soviet-American aerospace project."

"The working name is SPUT," Zerkanjian added, "an echo of Sputnik, our first space triumph, while for you Americans, it is an acronym standing for Space Pick Up Truck."

Colonel Kazdan leaned over and picked up an envelope out of the wastebasket. "In general," he said, "if you took the space shuttle, keeping the present engine while reducing its dimensions to ninety percent of the original, you would reduce its area to 0.81, its volume to a nominal 0.72. If you then change the skin to titanium, and the insulation to a silica aerogel having a density of about an eighth of solid silica, you achieve a substantial weight reduction, and when you reduce the payload from twenty tons to two tons, the weight reduction becomes even more substantial." He drew a little space shuttle underneath the numbers. "The estimate of our engineers is that the mass of such a vehicle would fall between 0.3 and 0.4 of the original."

"But the payload is reduced to one tenth," said Mario, "what do you gain?"

"With a sail area of 0.81 and a mass of 0.35, reentry velocities will be lower and therefore cooler," replied Kazdan. "Maybe 1,400 to 1,500 degrees Celsius, well below the melting point of titanium. One gets the ruggedness and simplicity of welded titanium in place of glued-on ceramic tiles made in a million different shapes."

"There are two other advantages to the low payload," said Dr. Zerkanjian easily, "the first of which is that it becomes less troublesome to insert the vehicle into low Earth orbit. Our preliminary estimate is that SPUT could reach such an orbit if launched from 12,000 meters at Mach 2, well within the capability of existing aircraft."

Voss looked at his assistant. "Mario?"

"There have been several studies along these lines," his aide said at last. "All on the edge of the envelope, all rejected by the military because the payload was too small to be useful."

"Making our peaceable intentions manifest," said the diplomat, spreading his hands. "We would use SPUT mainly to carry fuel and supplies into orbit in support of space stations in various locations."

"Of course," said Voss. "What's the second advantage you spoke of?"

"The light weight means that your powerful shuttle engine would be relatively unstressed," said Zerkanjian, "so that it would be more reliable, more rugged, more durable. . . ."

"A turnaround time of 24 hours ought to be possible," said Colonel Kazdan.

"Interesting," Mario said at last. "How many would you be in the market for?"

"Only half of them," replied Kazdan. "After all, the projects for which they are intended would be joint Soviet-American enterprises." He stroked his black mustache. "That might come to fifty or sixty, I suppose, but of course

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they will be simple little things, these SPUTs."

Oh come on, thought Voss. "What about the silica aerogel?"

"It turns out not to be terribly difficult to prepare, Mister Fuentes," said the KGB man. He opened his attaché case and took out a Xeroxed copy of an article. "From your *Scientific American,*" he said, scribbling some notes on the margin, "Here. Top secret stuff. See what you can do with it."

"What do you want us to do with it?" asked Voss.

"Show it around," said the diplomat. "If things go well, there could be something from the summit next year, and your friends in the Military Industrial Complex might wish to have proposals ready for submission."

"On the back of an envelope?"

Dr. Zerkanjian examined the envelope for a moment. "Why not?" he said. "It's all there. A smart man might make a lot of money from that information."

Morrie Greenbaum looked at the Xeroxed copies of the envelope and the article on aerogels. "Hey, Werner," he said, "this is not exactly high tech. This is dumbing down the state of the art to the point where even the Soviets can use it."

Voss leaned over the table and stirred cream into his coffee cup, which a solicitous waiter had just refilled. "Well, look who made the proposal."

"Yeah, sure. Did you check it at State?"

"They don't know anything," said the little congressman. "Why should they? This is a leak from the Soviet Embassy."

"Well hell, what do they want?" Greenbaum folded the copies longwise and slipped them into his jacket pocket.

"I told you what they said, Morrie. Maybe they want to build some titanium space vehicles." Voss sipped his coffee. "Is business so putrid that roughing out a proposal is going to put people into Chapter 11?"

"That ain't it," said the lobbyist. "This has all the earmarks of one of those joint Army-Navy programs, where you get change orders three times a week and no one ever has the final say on anything."

"They make money on those, too."

"The conglomerate does," said Greenbaum. "But you burn out some good engineers."

Voss leaned back in his seat. "Don't look so far down the road," he said. "The whole deal hinges on the summit next year, right?" The lobbyist nodded. "So pass the stuff on. At this point the whole thing is speculative as hell. A terrifying rumor of Russkis blowing smoke up the American kazoo. So the aerospace industry designs something *else* that never gets built. What's the big deal?"

"I don't know, Werner, I have a bad feeling about this."

The congressman pulled a face. "You want to sit on it, go ahead," he said mournfully. "The summit goes off and it turns out you're sitting on the straight dope, everyone will thank you for keeping them out of trouble. Especially when the French or Israelis get a job with all those changes."

"How big a job?" asked Greenbaum,

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taking the copies from his pocket and looking at them. "I mean, how big do you think?"

"Altogether? It could be as big as the B1B program, with both the US and the USSR doing procurement. It could never happen, too."

"Shit." The lobbyist put the copies back in his pocket. "I'll pass it on informally. I'll post it to the R & D guys as a certified rumor, and let them do whatever they damn well please." He took the copies out of his pocket and turned them over in his hands. "Shit!"

"What's the matter," said Voss, "you think you'll have to learn Russian to lobby the Soviets?"

A sigh. "No, no, Werner. It's just that they figure to take a real hard line on how their money gets spent. The GAO, they can be handled like always, but what are we going to do with the KGB?" He slipped the copies back in his pocket. "Next year's summit will be the deadline for whatever Mickey Mouse stuff the R&D clowns turn out." The lobbyist looked up, and nodded to the waiter for the check. "That's what you want, isn't it?"

Werner Voss finished his coffee. "What I want, as you have so often told me, is to get reelected. No big deal."

Chapter Three

Dave Kaplan took the red leather easy chair by Werner Voss' mahogany desk and sat back. "These things keep coming back to us in the White House," he said, handing over a Xeroxed copy of the back of an envelope. "The word is that you had something to do with this garbage."

"Yeah, yeah," said Voss, giving it a perfunctory glance. "The original is on file somewhere if you want to dust it for fingerprints."

"This isn't something we intend to go with, you know," Kaplan said softly. "What's the story?"

"A couple of guys from the Russian Embassy came over and gave it to me. The first secretary and some colonel. It was the colonel who made the notes you've got there."

"Names, please."

Voss pressed the intercom. "Martha, would you bring in the SPUT file for us?" They sat quietly until the secretary handed Voss the slender manila folder.

Kaplan took the folder from him and copied the names from the business cards taped inside. "Right," he said, handing the folder back to the congressman. "What did they want?"

Well hell, thought Voss, what does he think they want? "World domination, I suppose," he said mildly. "They conveyed the impression that this was something that might be pushed at the Geneva summit this summer, and since I had contacts with the aerospace industry. . . ." He shrugged. "They could have put the word out lots of ways. So?"

"You may have wasted a lot of man hours putting this Soviet disinformation out," said Kaplan. "Why didn't you just turn it over to the FBI?"

"Come on, Dave. What would the FBI do with it? Put it in a file and sit tight until somebody came along with a Freedom of Information action fifty years later? Nobody in the whole goddamned government is going to take action on that thing, not until their feet are held to the fire, and you know it."

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Kaplan looked annoyed, and then his face smoothed itself out. "It would've tipped their hand at the summit, maybe."

"Horseshit! The Russian Embassy decided to leak the information, presumably at the instructions of Moscow. So how does pretending we didn't hear what they said tip their hand?"

"Easy, Werner," said Kaplan. "No one is accusing you of being a dupe or anything. Maybe a little less than totally patriotic, but we expect that from Congress. Nevertheless, this administration has been under severe fiscal constraints from day one, due to the irresponsibility of past Congresses, as we like to say to each other in the Old Executive Office Bunker. The thing is, we now have to husband our resources to achieve those strategic objectives the president deems truly important." He leaned forward, resting his elbows on his knees. "This lightweight space vehicle is out of the question. We can't afford it."

"The Russians indicated they'd pay for half."

"We still can't afford it." A sigh. "We don't need it, either. Two tons of cargo is useless for anything we have in mind or anything we need to put in orbit. What are you going to do, assemble NASA Tinkertoys in space?"

Werner Voss studied the original envelope for a moment, and shook his head. "You might carry fuel into orbit," he suggested at last.

"Two tons of fuel is nothing!"

"A fleet of these things could haul up all the fuel you needed. Or are you trying to win a war without busting the budget?"

Kaplan rested his chin on one hand. "A fleet, huh? What do you know that you aren't telling me?"

"Nothing," replied Voss, "but I've been thinking about this since it happened. You want an educated guess?" The other nodded. "OK. At Geneva, y'all sit down at the table and the Soviets say: Hey, tovarishch, let's explore space together, for *peaceful* purposes. Not a one-time stunt like Soyuz-Apollo, but a real deal, starting with SPUT, here."

"SPUT? That's what you called the file. What is it?"

"Space Pick Up Truck, Dave. They'll offer to go halfsies with us, what could be fairer than that, *and* it will be designed and built in this country."

"The president won't buy it. I can tell you that right now. These days we have to be pretty damn careful about which ratholes we pour our money down."

The congressman grinned. "Congress has some questions about the ones you people are going with, Dave. Any comment on the X-ray laser, for instance? Or the E-30 program?"

"Not today," said Kaplan. "What *about* SPUT? How are the Soviets going to play it?"

"Hey, this is my guess as to what will happen, right? A pipeline to the Kremlin I ain't got. But suppose we trot off to the summit and they insist? The flat-out obvious move. What's the president going to do, hold a press conference and say the Cold War is back on?" Werner Voss sat back in his swivel chair. "There are companies in my district who would really, *really* like a piece of that pie."

Kaplan shook his head. "Let 'em wait. But you've put your finger on it,

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I think. A graceful turndown of an offer like that is going to require some work."

"Or maybe even some thought," agreed Voss, "whichever is harder. Maybe the first thing you'll want to do is decide whether or not you *should* turn the Russians down."

"Hey, Werner, we're moving with the SDI as fast as the deficit will let us, all right? This SPUT thing is going to be in competition for the exact same funding that we have to use with the other. No *way* the president is going to go with it."

Well hell, thought Voss. I suppose if I told him about the Russian strategy to permanently strangle the SDI with a competing program that might be really true. He glanced at the TV set that had been quietly covering the floor of the House on C-SPAN and stood up. "That's what the president gets paid for," he said easily, "making the tough decisions. Now if you'll excuse me, I've got to make a roll call."

The Geneva Summit, 2300 hours, day four. They sat around a long conference table, the American teams. State Department, Defense Department, and the Central Intelligence Agency on one side, White House people on the other.

"Well, hell," said Hamilton J. Morgan, the secretary of state, "the trouble is, once you start disarming, putting stuff on the table, there ain't nothing sacred."

"The Soviets offered to eliminate the strategic elements of the Red Navy," said Reuben Norbeck, of the National Security Council, "including *all* SLBMs, as well as their long range attack subs. That would simplify our defense strategy considerably." He had been a fighter pilot, and later a general in the Air Force.

A. Wilson Ferguson III, the deputy secretary of defense, shook his head. "The Navy couldn't buy the idea," he said flatly. "As Bill Shakespeare put it, 'Othello's occupation's gone.' With no Russian subs to keep track of, we'll be set up for big cutbacks."

"We can't reject the deal because of that," observed Stanley Valada, one of the senior analysts with the CIA. "Reject it because they want too much for too little."

"What's too much?" asked the White House's David Kaplan, who had been detailed to keep the minutes of the meeting because he had at one time been a court stenographer. "Both sides stopping production of tritium?"

"No," said Valada, "*that* actually is an interesting and possibly workable idea. The notion that we would each let our hydrogen fusion physics packages degrade with a 12.5 year halflife is consistent with the progressively higher accuracy of our electronic and inertial guidance packages."

"Theoretically, smarter bombs don't have to be so bloody powerful," said Ferguson. "That may be true, but the bottom line is that they want us to dismantle one leg of our defense triad, the ground based missiles, Minuteman, MX, Midgetman, the lot."

"That might not be such a bad idea," Hamilton J. Morgan said, rubbing his chin. "We'd have absolute control of the sea, and the Soviets wouldn't be contesting it."

"Look at the numbers," said Valada wearily. "The number of warheads we

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give up is a whole lot bigger than the number of warheads they give up, not to mention that ours, being land based, are a whole lot more accurate.''

''Well, hell,'' A. Wilson Ferguson III muttered. ''The whole point of the exercise was to give us an absolutely secure sea force, while allowing the Russians to have their land based missile silos equally secure. Our subs couldn't throw enough warheads to take out their land based missiles, but *they* wouldn't have the capability to take out our subs.'' He mumbled something.

''What was that?'' asked Kaplan.

''The Land Beast and the Sea Beast,'' replied Ferguson. ''They have a hard time fighting each other.''

''Right,'' said the secretary of state. ''But if our nuclear force is counterbalanced by theirs, what's to stop them from rolling over Europe?''

''Whatever the hell for?'' asked Dr. Bell, the other CIA analyst. ''They were talking reductions in conventional forces, they were talking elections in which the Party nominated a pair of candidates instead of *the* candidate. They were talking reform in *Poland* for chrissake!''

''They repeated their pledge not to launch a first strike,'' said the president.

''Yes, sir,'' said Hamilton J. Morgan. ''We had discussed that possibility. Why didn't you make a counter pledge never to hurl our armored might over the North German Plain in a surprise attack?''

''Because when the time came the idea seemed frivolous,'' said the president, rubbing the bridge of his nose. ''We're not going to give up silos for subs. But not because the deal is no good on the numbers, Reuben to the contrary notwithstanding. The premier made it plain this afternoon that such a reduction would be tied to severe restrictions on the SDI.''

''Makes sense,'' said Dr. White. ''Elimination of the SLBMs would do a lot for SDI.'' He paused. ''Maybe more than that, even.''

''Strategically, we have to press ahead on the SDI,'' the president said. ''On the other hand, what about the deal on tritium? Maybe there's room for something there.''

''Tritium was tied to the other stuff,'' Morgan said, shaking his leonine head. ''What's left?''

Somebody on the White House side turned over a sheet of paper on his yellow legal tablet. ''Something called SPUT,'' he said, covering a yawn. ''The Soviets proposed a joint proposal to build this so-called Space Pick Up Truck, in the U.S., with them funding half and us funding half.''

''That's a bad idea,'' said Kaplan, looking up from his stenotype machine. ''You just *know* that Congress is going to pull the funding for it out of the SDI budget.''

The president yawned in sympathy. ''Maybe,'' he agreed, ''but that's a long ways down the road. The sucker is doable, for what, maybe a couple hundred million a year over four years? If we don't pick up on SPUT, we're going to come off the summit empty handed.''

''Which will hurt the party in November,'' said one of the White House staffers. ''How much control do the Soviets need on spending their money?''

The president yawned again. ''I have a nine o'clock meeting with the premier,'' he said, ''and three nights in a

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row, well, I'm feeling it. Figure no on the Sea Beast-Land Beast deal, and no on phasing out the H-bomb. The SPUT looks harmless, so we'll go with it." He turned to one of his staff who seemed familiar with the subject. "Why should we go with it, Dave?"

Dave Kaplan shrugged and looked up from his stenotype machine. "We'll get first hand experience working with the Russians on a big project, sir. You can say that this is the first step for the rest of history."

"Right," said the president, nodding his agreement. "It might even turn out to be useful for the SDI."

Chapter Four

Werner Voss stood in the brilliant California sunlight wearing a white baseball cap and black sunglasses as the prototype SPUT came gliding smoothly down from her maiden flight.

"What do you think?" asked Mario.

"Looks good," replied Voss absently. She seems airworthy enough, he thought, and the reports from orbit were entirely . . . not satisfactory, what was the cant word . . . nominal. The trick is going to be the forty-eight hour turnaround time to put the beast back in the sky. How *could* they check out the main engine in that time? The technicians had sworn it could be done, but he had his doubts.

"They still have fuel for a twenty second burn at quarter thrust," said Julia Bell-something, the company's beautiful PR person, whose room was next to his at the motel. "That's enough to swing around for a second approach if they had to."

The SPUT touched down and rolled smoothly to a stop, braking far more easily than the ponderous shuttle had done.

"The trick to the fast turnaround time is keeping the engine in a state of readiness," she went on, repeating the briefing she had given earlier for want of anything better to say. "Liquid hydrogen in the tank at all times."

"So how do you know the engine won't leak or something?" he asked. as much to disrupt the pat spiel as for information.

"Because we have the book on it, Werner. This is the umpteenth revision of the shuttle engine and our pilots kept it running well below the design maximum." She smiled, showing perfect teeth. "The bird is kept fueled and chilled while they run through the preflight checklist, and when it passes, we'll take it up again."

"No problem, you think?" said Mario.

"No problem," said Julia. "See there? The fuel trucks are coming out. We ll have the ground crew in place to start the preflight checkup before you get back to the tour bus."

After a while the air-conditioned VIP bus rolled up to take them back to the motel, and they all got aboard, Werner Voss sitting next to Julia and behind Morrie Greenbaum and the vice president of Engineering, a Dr. Randolph, according to the company nameplate on his jacket.

"You fellows did a remarkable job turning out a prototype in forty-four months elapsed time," said Voss. "Were the Russians hard to work with?"

"Not really, but that's a question lots of people ask," said Randolph. "The Russian project manager, Doctor Par-

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etzkin, was as sharp as they come, and his people were all first rate. The other thing was how the project was set up. See, NASA couldn't make changes without Soviet approval, and vice versa, and the result was that very few changes were ever put through."

"Tell him about the E-30," said Morrie.

"Oh, right." Randolph shifted his weight around in the seat. "See, the computer simulation was showing erosion on the titanium. Not everywhere, just on the leading edges and the control surfaces, you know? And not very much, either. It was subcritical until the fourth or fifth iteration, at which point it got critical very fast. So Paretzkin comes in and says, hey, you people have solved that problem on the E-30 program, already."

"The Orient Express?" asked Voss.

"Right," said Morrie, "that's the public relations tag, but it was funded by the USAF, who were hoping to get the B-3 out of it."

"Scramjets," said Randolph. "They were supposed to deliver Mach 25, to go into orbit, but after about Mach 10—that's classified, by the way—the fuel consumption went right through the roof."

"Couldn't they fiddle around with the design a little?" asked Julia.

"They did, everything you could think of. Turns out that the computer design, which is what they built originally, was just about the best that could be done. Turns out we were just sitting on the saddle point between extinction and chaotic turbulence."

Voss nodded. Mario had read the reports on the cancellation of the E-30 program and told him something vaguely similar. "Go on."

"Anyway, I found out about all this later. At that point, none of *us* knew about the project, but Paretzkin got on the horn to Washington, and they put him through to the secretary of the Air Force. And his end of the conversation goes something like this: 'Yes, yes, it is a pleasure to talk with you. Fine, fine, and you can call me Boris Alexandrovich. Beautiful, beautiful. Look,' he says, obviously interrupting the secretary in the middle of something, 'your E-30 program uses carbon/carbon composites on the leading edges of hypersonic airfoils, and they have developed a plasma deposition technique to apply two to three tenths of a millimeter of silicon carbide so the hot carbon isn't oxidized. We have need of that material.' Then there is a long pause, and Paretzkin says: 'Why Sam, if you won't give it to us, I'll just have to call the Embassy.' And damned if the Air Force didn't send over a couple of technicians with the equipment."

"Why? Did the Embassy have the information already?"

"No, no, Werner, the Soviet Embassy would have complained to the premier who would have complained to the president. See, it turns out that the reason Paretzkin knew about the stuff was that he read about it in a trade journal, heavily censored of course, but he knew enough to fill in the details." He looked around the bus and lowered his voice. "See, the way it works is first you warm the carbon/carbon stuff in the presence of silane to film it with silicon, and then you flash it with a tunable laser to react the film to silicon carbide, and

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then you use this torch with traces of silane and methane in the central hydrogen jet, and it grows isotaxic silicon carbide on the silicon carbide you already have in place. You know what was really funny?"

Voss shook his head as the bus pulled up outside the motel.

"What was funny was that you only need about 0.1 millimeter for your coating, but when the Air Force had started out, they laid down 0.25 millimeter. Paretzkin guessed how thick by accident, and the secretary thought he was going to the Embassy to get the plans!"

Werner Voss laughed and put his arm around Julia's shoulders.

The motel bar didn't require jackets, but the air conditioning was set high enough so that you'd wish you'd worn one if you hadn't. Congressman Voss sat in a red leather booth with his aide, Mario Fuentes, and W. Roscoe McCullough, the president of McCullough Aerospace, a subsidiary of C. Itoh, the Japanese trading firm, and a major employer in his district. They were drinking beer from a pitcher on the table and waiting for the topless dancer to come on.

"I gotta hand it to you, Werner," said Old Man McCullough, pronouncing it Varneh, "you steered me straight on what the Russkis wanted on this deal, and the company did all right on the contract. What I want to know now is where do we go from here?"

"What do you think, Mario?"

A shrug. "The Russians were talking about placing an initial order for a couple, including spare engines if it performs up to spec."

"Ah shit, that's small potatoes, even with the spare parts." The Old Man refilled his glass from the pitcher. "They have four shuttles in the fleet, doing all sorts of defense work while they try to support that pitiful half-ass space station they got up there. The SPUT, now, with the SPUT we could have the damn *Washington Post* delivered in orbit. We could *commute,* for chrissakes! I don't want to sell it to the Russkis, I want to sell it to *us!*"

"Take it easy," said Voss, "the Japanese don't care who you sell it to. OK?"

"Werner, I can't get anybody interested in the damn thing, and she works just fine! Those crackerass bureaucrats in the Pentagon don't care how good it works, they just want to go on using them crappy old machines they built their own selves."

"What, you think the world should be beating a path to your door, starting with the Pentagon?" Werner Voss laughed. "That ain't the way things work, not in Washington, anyway." He took a sip of beer. "You want to know where your business is going to come from?"

"It'll come from where the money is," said McCullough, brushing back his white hair, "and where the money is is the damn Defense budget. Now you got me SPUT, and I appreciate your help, but I badly need to sell this bird to the Air Force or someone, and you've got to show me how!"

"Hey, Mac," said Voss laying a hand on his arm, "come August, the president is going off to Toronto for the summit. When he gets there, the Russians are going to want to continue this

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brilliantly successful program—assuming you people don't screw it up—and the president is going to want an agreement with the Russians because he can't cut down on our NATO commitment without one. So there *will* be an agreement, OK? And then it will be up to Congress to implement that agreement. And then, maybe, the orders will start rolling in."

"You're telling me to wait till fall?"

Voss shook his head. "I'm telling you not to make waves. You want the Air Force's business? Wait until they see what you can do and figure out how to use it, then they'll come a-running. Maybe. In the meantime? Sit tight. Take the Russian order, which will make the Japanese very happy, and see what happens."

"Werner, a few miles out on the tarmac you can see the SPUT sitting on the back of the little old 747 we fixed up to launch it from. My engineers tell me we could launch it right now if you people didn't want to run through that damn checklist. Now why can't I sell her to the good old USAF?"

Voss shifted in his seat. "Tell him, Mario."

A shrug. "They don't have the money, the Air Force," his aide said, taking a swallow of beer.

If the summit goes off OK, they won't get it, either, thought Voss. "It's true, Mac," he said. "The E-30 program was the last big ticket item the flyboys had funding for, and when it turned out that you can't fly into orbit like a big hydrogen-burning bird, they were up the proverbial creek without the proverbial paddle."

"Then who does, for chrissakes?"

"NASA," said Mario, "to support the space platform. And the SDIO, which is trying to get all the assorted pieces of Star Wars in place. What Werner was telling you was that first they'll see what you have, then they'll figure out a way to use it, and then, *then* they'll come around to do a buy."

"I don't give a shit," said McCullough. "We got us a real sweet pigeon here, and I want you boys to find me a way to sell it to the goddamn Air Force!"

Mario looked over at his boss and shrugged. "Well, sir, we'll see what can be done."

"Right," said Werner Voss. "The first thing we need to do is get their attention."

Then the band started playing, the spotlight picking up the flash of sequins from the topless dancer's minimal costume, and the three men sat back to watch the show.

The office of the secretary of the Air Force was impressively spacious and decorated with models of various aircraft that small boys of every age would die for. The secretary himself was the very exemplar of old money, tall and lean, impeccably dressed, with excellent manners and superlative connections. "The Kelly-Green report?" he said, with a touch of disdain. "You can't be serious."

Voss sat back on the couch and smiled, wondering if he was making a mistake. Better the report should have had other authors, but you go with what you got. "Hey, Archie," he said softly, "read your history. In the old days the Army Air Corps made a big deal about the so-called Battleship Admirals, the

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old fogies who clung to the obsolete hardware they knew and loved. It wasn't anybody's smart-ass arguments that ended the age of the battleship, it was the cold, hard facts. The Kelly-Green report takes a cold, hard look at the role of the manned bomber in the present day."

"You are serious," said the secretary, raising an eyebrow to express well-bred astonishment. Then he delivered the cut. "I had expected better of you, actually."

One can be serious and still wind up on the short end of the stick, thought Voss. Still, we'll give it a shot. "Congress is, as you are no doubt aware, under considerable pressure to do something about the deficit. One possibility which is under active consideration is the reorganization of the Armed Forces into the Army and the Navy." That's your job, sucker. Do I have your attention? "The Kelly-Green report, which questions the need for manned bombers in a world of increasingly accurate ballistic missiles and cruise missiles, is going to be the basis for some real heated discussion."

"I haven't read the report, yet," said the secretary, coolly. "However, I am confident that manned bombers will be seen as vital to a strong and balanced defense."

"Are you, now? Look, Archie, the Air Force has blown more money than I like to think about on these assorted superplanes that don't work right." Voss leaned forward. "Manned bombers are going into mothballs, just like the World War II battleships. They are big, beautiful, expensive, obsolete toys that we can't afford to let you elitist twits play with any more." Elitist twits? he thought, oh shit, I let the son of a bitch get to me!

The secretary laughed. "Really, now, Werner, 'Nothing can stop the US Air Force!' "

"The line was written: 'Nothing can stop the Army Air Corps,' which is a better rhyme, and maybe a better T/O, as well! What I'm telling you is that the manned bomber is going the way of the battleship!" I'm not getting through, thought Voss, why did I let him rattle me? "Has *gone* the way of the battleship."

"The manned bomber is central to the role of the US Air Force," said the elegant man behind the desk. "Unthinkable that we should ever give it up, utterly unthinkable."

Voss played his last card in an effort at being sweetly reasonable. "How many nuclear plants around the country have been closed down just when they were ready to be put on line?"

"What? Two, maybe three if you count the DOE retrofit at Hanford that never got off the ground."

"Right. And why? Because the people are scared silly of nuclear power. They know they need it for defense, but they're still scared of it." Congressman Voss sat back in his chair and crossed his legs. "So now we're talking about manned *nuclear* bombers, and the argument is that we don't need them, because they are obsolete. And you know something, Archie?"

The secretary looked at him from under half-closed eyelids, and shook his head.

"The argument is real simple. A nuclear war would be over before the

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manned bombers ever got to their targets, so what the hell good are they?''

''We can always call a manned bomber back, Werner.''

''And you can always use a battleship to shoot its sixteen-inch guns at guerillas in Lebanon. So what?''

The elegant man studied his carefully manicured fingernails. ''This isn't the first time the subject has come up, you know,'' he said at last. ''What you say may have elements of truth, but you can't beat a horse with no horse, and there's nothing in sight to replace the manned bomber.''

Voss stood up. That's it, he thought, whatever the reason the man isn't going to move. Maybe he can't, but there's no talking to him, no way to cut a deal. ''That's too bad for the Air Force,'' he said, ''because if they can't find *something*, they're going to join the Luftwaffe in the dustbin of history.''

The secretary tilted his head slightly, to look down that patrician nose at his departing visitor. ''What did you have in mind, the McCullough SPUT? It is, I understand, largely manufactured in your own district.''

The congressman paused at the door, wondering if that was an offer. Probably not, he decided, Archie's tone of voice made it a put-down. ''The thought had occurred to me, but no. What could the Air Force *possibly* do with it?''

Chapter Five

The thirty-second news bite showed Werner Voss in his rumpled blue suit with an off-center red tie, looking directly into the camera. The question from the aggressively blow-dried anchorman was: ''Don't you think this row you've conjured up will hurt the president at the Toronto summit?'' Voss blinked. ''Why no,'' he said, ''if the manned bomber is as obsolete as it appears to be, the Russians ought to give us something for keeping it.'' ''But you're destroying the defense triad!'' said the anchorman. ''Well, sure, three is a magic number,'' said Voss, ''but one-third of our strategic defense is unable to do *anything!* Who needs it?''

Sheldon poured himself a second cup of coffee from the stainless steel thermos, and finished off the bottle of Cointreau sitting beside it on the credenza. ''I saw you on '60 Minutes' '' he said, ''and I caught you and Archibald Warbucks having at each other on the Ted Koppel Show. I didn't think you had it in you, Werner, I really didn't.''

''The secretary of the Air Force is Archie Warrenton,'' said Werner Voss, ''not Warbucks. And to tell the truth, if I had known how this thing was going to break. . . .'' He shrugged. ''You wouldn't *believe* the support I've been getting from the Army and the Navy.''

''You just came flat out and called for the abolition of the Strategic Air Command!''

Voss looked embarrassed at the unsought approbation of his son-in-law. ''No big deal. If you think about all the nuclear missiles in silos and submarines, what are you going to do poking around in airplanes? Nothing, is what. They pose a strategic threat, says Archie. Really? says I. Enough of a threat to provoke a Soviet first strike? We'd never deploy them like that, says he. Then they *aren't* a strategic threat, says I; make up your mind. Well, says Archie, you can threaten to threaten.'' He

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took a sip of brandied coffee. "That was the before part. Afterwards is no better, all our bombers aloft and armed with H-bombs, and no targets that haven't been destroyed and no bases to return to. Pathetic, I said. They might be what wins the war, says Archie."

"And then you destroyed him," said Sheldon.

"What? Oh, you mean about them having five or six hours to figure out what the Air Force hasn't been able to figure out in fifty years?"

"Yes, yes! That nailed him! I was just so pleased with you I didn't know what to do!"

Pleasing you wasn't what I had in mind, thought Voss, but just because a Liberal believes something doesn't guarantee it isn't true. Mario tells me the mail is just unprecedented, and running about ten to one our way. "Well, we went back and forth and round about. Archie was being rigorously logical, and if he had the worst of it, it was because the world has changed and the Air Force hasn't."

"Oh yes! It was a great victory for the Goddess!"

Voss put down his coffee cup. "Say what?"

Sheldon looked at him. "The Goddess, the Earth Mother, Gaia some call her. The coming of the Age of Aquarius marked her return after the long rule of the Sky Father."

"The Age of Aquarius? That was back in the sixties."

Sheldon laughed. "Well sure, Werner, but we're talking millenial epochs here. Really great changes take a while to manifest themselves, and the Sky Father became ascendant about the time agriculture was invented. So even though it's time for a change, it's going to take time."

"What sort of garbage has Doctor Chavez been feeding you, Sheldon? I recognize that sweeping time span, agriculture to the atom bomb, even if there is some baroque decoration tacked on."

"No garbage," said his son-in-law cheerfully. "Just one of the great sweeping cycles of history that the poor sons of bitches being swept out would just as soon not see. Manned bombers are obsolete, right? Well, so are armies, and navies, and the virile, manly God they worshipped."

"Sheldon . . ." Voss sat forward in his chair. "What is this?"

"Oh, the Earth Mother was fecundity, the life principal, the Jungian archetypal female if you want to be scientific, and the Sky Father was her polar opposite, you know, flaming death from the skies raining upon unbelievers?" Sheldon took a sip of his coffee. "The SAC is surely the very personification of the Sky Father, which you, you old iconoclast, have just knocked into, into, ah . . ."

"The phrase you want is 'The dustbin of history,' " said the congressman with a sigh. A Liberal believing something might not prove it was false, but false was the way to bet.

The president sat in the Oval Office with Reuben Norbeck, head of the National Security Council, A. Wilson Ferguson III, the former Secretary of Defense, who was now acting head of the CIA, pending Senate confirmation, and the multitalented Dave Kaplan, re-

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cently promoted to Chief Congressional Liaison Officer.

"When I came on, Mister President, you said what you wanted was someone to read and critique what the agencies were putting out," said Norbeck. "No partisanship, you said, no slanting, just as close to the unvarnished reality as I could get."

The president merely nodded. "So?"

"So taking you at your word, this flap over the Kelly-Green report has generated a lot of discussion, a lot of heat." He turned over the page on his yellow pad. "The bottom line is that Congressman Voss appears to be fronting for the Navy, while the Army is arguing for the decentralization of the Tactical Bombing Command to make their own mission easier to accomplish. OK? Discounting all the static and noise, Voss and the Navy have a case. The Army . . ." He rocked his hand in a balance motion. "They have a case, too, but it isn't real strong."

"What has the Air Force been saying?"

"The Air Force hasn't *made* any effective counterarguments, sir, just Archie Warrenton trumpeting slogans and pounding on the table."

"What about the top brass? General Thompson was on the Ted Koppel show last night."

"Same thing, basically." Norbeck removed his glasses and rubbed his eyes. "Try to cut to the issues you get nothing, at least Koppel couldn't. General Thompson talked about the glorious past, and the great things they'll do once the E-30 program gets the bugs worked out."

"The E-30 is dead," said Kaplan, "and Thompson knows it as well as anyone. Maybe better. If he said that, he's blowing smoke."

"That's sort of what the polls reflect," said the president, nodding thoughtfully. "The Air Force is just a tad shaky to be a proper pillar of the establishment."

"So we'll look into it," Ferguson said. "For Toronto?"

The president nodded. "Toronto will be my third, and I expect last, summit, and the Soviets are coming back at us with the Land Beast and Sea Beast proposal, which we will reject, and the proposal to eliminate the production of tritium, which seems reckless." He leafed through a folder on his desk. "Old wine in new bottles. Which means we need to make some sort of preemptive counteroffer. Suppose we decide to eliminate not silos for submarines, but bombers for bombers? Could we do that?"

"Manned bombers, yes. Cruise missiles, no." said Ferguson. "The cruise missile is too useful a means of projecting national power to give up."

"Sort of a car bomb for the rich and famous," said Kaplan. "But the big planes? Voss is right, I'm afraid—they've seen their day."

"Then we'll pencil in the idea for exploration," said the president. "Dave, I want you to sound out Capitol Hill. Ferguson, I want you to figure out what's left of the Air Force after the manned bomber is gone, and where it ought to go. I'd be inclined to put the Minutemen under the Army."

"Makes sense," said the CIA chief. "That way the Army and Navy both

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have a strategic mission. What about the tactical forces?"

"What do you think, Norbeck, Dave?"

"Logically the ground support mission would go with the Army," said Norbeck. "The Marines have their own planes."

"The Air Transport Command would go to the Navy," said Kaplan. "Look at it as an extension of overseas logistical support."

The president made a note. "Right. That's kind of sketchy, but it will do for a start. Ferguson, have your people do a workup along those lines. Dave, float the idea with the heavy hitters. Not Voss, he's in it too deep to help anyone, but Bradley, Rhinelander, maybe Kennedy. Ask what they think."

"So after I get their input, then what?"

A shrug. "Step two is when Ferguson comes back with a list of bases we can close. That's when the shit is going to hit the fan, when you go around the districts shutting down airbases."

The Congressional Liaison smiled, showing his lower teeth like a shark. "But look at the money we'll save," he said softly. "What about estimated savings?"

"Too early for that, Dave, way too early. Besides, we both know that they're going to be funneled into the SDIO, so they won't be available for the good old pork barrel."

Kaplan made a note and sat back. "No sir. We won't get more than half, not if it gets done. Especially not the first year or two. I'll talk to some of the old boys heading up the committees and see what sort of reaction we get. A big estimated savings would do a lot to help them see it our way. What if this thing leaks?" Which, he thought, will surely happen, and sooner rather than later.

"We could say we're behind manned bombers 1000 percent," said the president, and then shook his head. "No, no. Nobody would catch the allusion to poor old McGovern." He shrugged. "Let it leak. If they ask me about it, I'll say that I was having my staff check out what the Kelly-Green report was saying and fuzz it over."

"A leak could be critical," said Ferguson.

"Not here, not with this," said the president. "If Warrenton can't do better defending his turf than he has against Voss, the manned bomber is history."

"Don't underrate the Air Force," said Ferguson. "If they get the wind up they could take the play away from you."

The president made a note. "Nothing can stop the U.S. Air Force," he said gently, "but if the manned bomber is eliminated, who needs it?"

"The American offer is garbage!" said General Kurgan, lighting a new cigarette with the butt of his old one. "Garbage! They will scrap their useless goddamned bombers *anyway!* You read the intelligence estimates, why should we give them *anything* for rationalizing their armed forces?" He stubbed out the butt in an overflowing ashtray. It was the evening of the third day at the Toronto summit, and the Soviet negotiating team was deeply divided over the proper course of action to follow.

"You take a rather narrow view, General," said veteran arms control

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negotiator, Anatoly Slansky, mildly. "They rejected the Land Beast-Sea Beast scenario again, as we rather expected they would. They will continue to manufacture tritium, as we had hoped they would not. The SDIO appears to be firmly entrenched in the American institutional firmament despite our best efforts. Surely a mutual dismantling of manned bombers is worth *something?*"

Holding his cigarette between thumb and forefinger, Kurgan extended his little finger and shook it at Slansky. "Less than this," he said sourly. "Any money they save on manned bombers will be funneled directly into the SDIO."

"They reportedly have a mirror for their directed force X-ray laser," said a technician, "a block of oriented molybdenum disulfide, that increases the intensity of the lased X-rays by two to four times."

Slansky shook his head. "Our own work indicates that approach is a dead end. We have good people, we should trust them instead of believing the boasts of our enemies."

A second technician looked up from the notebook she had been leafing through. "The work Ivan Nikolayevich refers to was the result of computer modeling, not any experimental breakthrough," she said. "We have been getting sufficient access to the results of their computer modeling program to suggest a deliberate disinformation program."

Again Slansky shook his head. "Then it would be internal disinformation as well, Maritsa," he said. "Unheard of in any well regulated society." That provoked a general laugh.

The premier entered and took his seat at the head of the table. "The Americans continue to be obsessed with our internal affairs," he said, slapping his portfolio on the table. "This time, at least, they have an interesting variation to their usual notion that anything unlike themselves is evil."

Slansky looked interested, "What, the argument that an infallible party was good theology but poor engineering?"

The premier made a rude noise. "A joke made for home consumption," he said, "one learns to expect such fleers and gibes from the uncultured. No, the president observed that large institutions, such as exist in both our countries, do not willingly acknowledge or correct mistakes. His analogy was that a car needs not only a steering wheel, but also brakes, and that the best brake for any institution is to insist on its adherence to the law."

Kurgan blew smoke. "Ah, then that was what he was about when he said the several organs of the Soviet state ought to be monitored by some kind of Inspector General. The Americans would greatly enjoy the loss of efficiency such an arrangement would entail."

"Perhaps," conceded the premier, "but the judicious use of such an arrangement might recentralize much of the power that has flowed insensibly into the bureaucracy." He shook his head. "Recent American experience suggests that a head of state has more discretion enforcing the lawful conduct of his bureaucrats than one might have expected." He removed several briefing books and sorted through them. "Well," he said at last, "the matter merits further study. Probably there is nothing we can

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do here that can be put on the table as a so-called 'concession.' "

"You'd actually consider tying ourselves in legalistic knots?"

The premier nodded. "Eventually," he said. "The counteroffer the Americans put on the table, now, that requires an immediate decision." He rested his elbows on the table and leaned forward. "So," he continued, "what ought to be done for the good of Mother Russia?"

"Reject the treacherous American offer out of hand," said General Kurgan. "They just want to spend the money on Star Wars."

"Perhaps," agreed the premier. "If they want to end their manned bomber program, we can't stop them, can we, General?"

Kurgan took a drag on his cigarette and let the smoke trickle through his nose. "No. Well, not easily anyway. But why play into their hands to let them claim a propaganda victory?"

"Any such victory would be shared," said Slansky. "Besides, we *also* would incur huge savings. Not in our dismantled bombers so much as in the reductions we could make in our Air Defense Command."

"Something has to be done about the SDIO," said Kurgan. "We cannot let this deadly threat to the Motherland be forever ignored."

"It may not be all that deadly," Slansky observed. "We thought for awhile that the E-30 program was a threat, and it turned out that God's speed limits took care of it for us."

"You are a fool to underestimate the Americans or to rely on God's mercy," Kurgan said with a touch of asperity. He took a drag on his cigarette and blew a smoke ring at the ceiling.

The premier leafed through the pages in his leather portfolio. "We might continue with the SPUT program," he said at last. "We have the prototype vehicle, after all."

Kurgan looked up. "We got so much grief from that so-called cooperative effort. . . ." He took a deep breath. "What did you have in mind, sir?"

"Our original plan seems to have been to conduct a joint space venture with the Americans," said the premier, turning a page. "A Lunar orbiting space station. The SPUT project proved to be unexpectedly aggravating for mostly nontechnical reasons so we let it slide, even though it might have been marginally useful. In fact the two vehicles we committed ourselves to have been ordered, and that seems to be the end of it." He turned another page. "Suppose tomorrow I tell the president, yes, fine, we agree. But. What's my 'but'?"

Slansky leaned back from the table and scratched his greying head. "Tell him that the Russian people felt very good about cooperating with the U.S. on the SPUT program, and that they would hope that it could be continued. Which is true, if somewhat irrelevant. Give him a sheet of the commemorative one ruble stamps we issued to prove it."

The premier made a note. "What else? I can't say the SPUT project should soak up most of the projected savings that might otherwise go directly into the SDIO."

"Just say that we prize SPUT as the most recent example of Soviet-American cooperation," said Ivan Nikolayevich, "and don't mention all the

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heartburn it caused at the Space Institute. You know, go on about how we would like to continue and expand these efforts in the interest of promoting peace in outer space."

"They'll read that as trying to strangle the SDIO."

Slansky covered a yawn. "Let them," he said. "We are, aren't we?"

The premier glanced at his watch. "It's a good line," he conceded. "What will I actually be talking about, here? I mean the physical object we're promoting."

Kurgan took out his mechanical pencil and began to scribble on the back of an envelope. "This was something that was developed and then discarded. The plans would be in the Space Institute if we need them."

The premier nodded. "Later, perhaps. The details can be filled in if we agree. Right now, give me a rough guess as to what the Lunar Station would need."

Kurgan started to erase part of his drawing. "Call the Institute?" He shook his head. "They've all gone home for the night."

"The plan called for three of the disposable belly tanks from the shuttle," said Maritsa. "In general, one was for living, one was for liquid oxygen, and one was for fuel, USMD, unsymmetrical dimethyl hydrazine. The control room and the rocket motor was in the joint which provided access and aligned the tanks at a sixty degree angle to each other, like one face of a tetrahedron. The idea was to fuel it in low Earth orbit and fly the whole assembly into Lunar orbit."

"Did you work on that?" asked Kurgan, looking up.

"Not directly," she said, "my assignment was to abstract the reports for circulation at the Institute, but I was interested and paid attention."

"Good enough," said the premier. "How many SPUTs should we want in support?"

General Kurgan stubbed out his cigarette. "Ask for ten, no, a dozen. Settle for what? Five?"

"Settle for six," said Slansky. "We order one more, the Americans order three."

"I was going for five each!"

The premier made a note to himself. "We'll see what we can get," he said at last. "Since it was originally a Soviet initiative, the Americans will give us credit for deep strategic planning and it will look like a fall back position."

Chapter Six

Mario Fuentes caught up with Congressman Voss in the hall outside his office. "You heard, boss?"

"What, that I have a contested primary?" A shrug. Bad news travels fast. "You must be the fourth person to tell me, already."

"We have a bit of a book on him," said Mario. "Joseph R. Conte, a lawyer, age thirty-six, no military service, married and divorced twice, no children. Active in local politics, he's never held elective office." He hesitated. "You'll want to check this out: I was told that he has connections with the hard right."

"We have a lot of those," Voss said, "and with the economy bent out of shape the way it is, raising money is

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going to be a problem. Where's his coming from?''

''We'll find out, I expect.'' Mario spread his hands. ''On the record, the man has no substance to speak of.''

When they got back to the office Benjamin Morton, Voss' campaign manager, had a fax picture of Conte waiting for them. They looked at it for a moment. ''The jaw juts,'' said Voss, ''and the mouth is set mean. You'd think he'd have lips, wouldn't you?''

''I expect he does,'' Mario replied, ''he just doesn't let them show.''

Werner Voss nodded. ''Perhaps,'' he conceded. ''Mister Conte looks like one real hard nosed-hombre, so maybe we have a fight on our hands. It'll take what, a half million just for the primary?''

''Easy,'' said Morton. ''It could go a whole lot higher than that, even.''

Mario shrugged. ''The other thing I had was on the treaty. The Senate voted for cloture, and they're going to move the question.'' He studied Conte's picture. ''He doesn't *look* mean, not really.''

''Hah. If Mister Rogers was in a primary against you, he'd start to look evil real soon. Conte already does.'' The phone rang, and the secretary stuck her head in a moment later.

''The Senate just ratified,'' she said. ''Yearian thought you should know.''

''That's good.'' The treaty, the principal fruit of the Toronto summit, called for the establishment of a joint Soviet-American Lunar Space Station, to carry out the broadest sort of feasibility studies regarding establishing a permanent Lunar Base. The sticking point with the Senate conservatives was that it would give the Soviets a direct hand on the American budget process by obligating each side to match the other's expenditure within certain limits. ''The talk at McCullough Aerospace was that they might be building a minimum of eight and possibly as many as twelve SPUTs over the next two years.''

''Maybe that's not so good,'' said Morton. ''The word is Conte got his start-up money from McCullough executives.''

Voss raised his eyebrows. ''Oh? What seems to be *their* problem?''

''McCullough hired a lot of ex-Air Force types,'' replied Morton. ''And you know the old man makes Barry Goldwater look like a flaming liberal.''

''One might even call him reactionary,'' conceded the congressman. ''So?''

''So Mister McCullough's been lobbying the Senate against the treaty, even though he's going to be building the SPUT, because he opposes the elimination of the manned bomber.''

''I hadn't heard that he was lobbying,'' sighed Voss, ''but he'll still build it?''

Morton shrugged and rocked one hand. ''He never said he would, but C. Itoh won't put up with any foolishness so he probably will have to. Anyway, the Old Man has been a heavy contributor to those Save The Air Force PACs that have been springing up around the country.''

''Oh shit. So he's contributed the max to me, and ten times that to my primary opponent?''

''More like twenty times, OK? McCullough is upset because if the manned bomber goes down the tubes, the Air Force is going to get rationalized

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into something for the 21st Century with no place for everything he believes in."

Oh hell, thought Voss. McCullough *believes* in the Air Force, and he isn't going to listen to why it ought to be reorganized. "That was the president's decision, not mine. Would it help to tell him that?"

"I already did," said Morton. "He appreciates your help, but what he says is that it's time to get some so-called 'new' ideas into Congress. Send a message to Washington. That sort of thing."

"Right. We-el, then . . ." Voss rubbed the back of his neck. Sweet reason wasn't going to do it for him. "Half a million in the primary, you think?"

"At least. You can figure Conte is going to outspend you maybe three to two."

Disgusting, but probably true. "Any ideas, Ben?"

The campaign manager shrugged. "A couple," he said at last. "The president ran ahead of the ticket in your district two years ago, and he's still popular, OK? He's committed himself to eliminating the manned bomber, and from that it logically follows that the Air Force ought to be reorganized. Make sure he's behind you, and get in front on the issue, so that we have a referendum on *his* policy."

Voss nodded. "Which kind of obligates him to do a bit of campaigning in my district. Well, maybe. He'd help, I suppose."

"You don't like the idea?"

"I do like the idea, Ben, but the reason I like it is because it puts my thumb in the eye of Old Man McCullough. The politics of spite. I have no idea whether it would do all that much to win the damned primary."

"I don't know either, but the free media exposure couldn't hurt. The other thing is to wait for Conte to challenge you to a debate, which he figures to do, and take him up on it when he does."

"You mean treat the rotten son of a bitch as an equal?"

Ben Morton nodded. "Well, sure. You've got an issue that will carry over to the general election."

Voss grimaced. "I'll bet he's one of those ideological hotshots that never lose an argument."

"Maybe," agreed Morton. "That's something we need to check out. The public takes a dim view of the smartass who never concedes a point. We also need to know where he stands on the issues."

"No problem," said the congressman. "You can just watch to see where he starts attacking us."

They sat around the suite in the hotel, watching the election returns, Werner Voss, and his family and his top campaign staff.

"Well, so much for the issues," said Voss, putting his feet up.

"We found that out with Conte," replied Morton. "Up to the last fortnight before the primary he was gaining on you, and if he hadn't started to do a number on 'the Jew Voss,' he might have taken it."

"He tried to have it both ways," said Voss. "He was attacking me for being Jewish and also for not supporting Israel. I suppose the appeal was to different voting blocs."

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His wife looked up. "You support Israel," she said. "What have I missed?"

Werner Voss took a sip of whiskey and water. "Oh, not much, I supported the Prosky Plan, a variation on the American lust for negotiations." Seeing that his wife was still interested, he continued. "The West Bank and Gaza, the real estate there is mostly owned by Israelis, you understand? So there was this policy breakfast over at State and when they asked if anyone had any ideas I said, fine, take the Arabs in Israel, and move them to the West Bank, giving them property *there* in compensation for the property they leave behind. Use the rest of the property to settle as many claims left over from 1949 as you can. And then turn the Palestinians loose. Tell 'em they can have any kind of government they want. Only when they try to push Israel into the sea, they'd better not fail. What the U.S. would do, would have done, is compensate Israel for the net loss of property the scheme would incur."

His wife nodded. "That seems fair to me," she said.

"The Prosky Plan?" said Sheldon. "Was that you?"

"Prosky wrote it up and pushed it," said the congressman, "but I was one of the signatories to that ad in the *New York Times* and the *Washington Post* along with a few others. The only thing the Israelis liked about it was that they wouldn't have to negotiate with the Palestinians, the plan was something that could be inflicted upon them. The Palestinians . . ." He shrugged.

"What about the Palestinians?" asked Mario Fuentes.

"Oh, the PLO said they'd kill any Israeli Arabs settled in the West Bank or Gaza as Zionist agents, and the Israelis were split six ways on the idea anyway. The Prosky Plan wasn't going anywhere, especially after the Administration backed off on funding it." Voss shook his head. "What turned the primary around was Conte's kid brother."

"The one they caught painting swastikas on the synagogue?"

"That's the one. Conte was doing all right with the issues. Never mind he had his head up his ass. The voters respond to the idea of brave young men in big, flashy, powerful machines defending the country." Werner Voss put his empty glass on the coffee table. "It's primal, something you don't have to think about, a gut issue. Tell 'em the machines are obsolete. Tell 'em the machines are useless. Prove it till you turn blue in the face. They'll agree with you, but they don't want to turn loose."

"Case-Johnson picked up on that issue," said Morton. "She's all in favor of a strong defense, and a strong defense needs manned bombers. We spent more than we could afford in the primary, and it's hard to argue the damn details in thirty-second TV ads."

"We're leading 50.4 to 49.6," said Sheldon, watching the TV screen.

"Last time we took it 61 to 39," sighed Voss. "This could be a long night."

"The president didn't help all that much, either," said Mario, leaning forward on the couch. "The treaty is signed. The manned bombers are dismantled, at least big suckers, the B-52s, the B-1-Bs, and the B-2s. The Air Force? All sorts of talk about finding

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them a new mission, but nobody has any suggestions. And all sorts of talk about those great savings, but so far they haven't closed down base one."

"The president," said Voss raising his refreshed glass. "The president has said that after this election a commission will be formed to study the reorganization of the Defense Department."

His campaign staff drank to the president and his commission, and Voss put his glass back on the coffee table. "What do you think, Mario?"

"The Air Force will be here long after this president is retired to the Home for Senior Statesman, and maybe the next one as well. The right, incuding the Fundamentalists, the Movement Conservatives, the Hard Right, all that lot, finally have an issue they can agree on. The technology doesn't seem to have all that much to do with it."

"Hey," said Sheldon, getting up to refill his glass, "it makes sense that bombers are obsolete like battleships. I mean it really *does*, Werner. So why isn't the public letting go of the Air Force when it can't have bombers anymore?"

"Good question," said the congressman, gazing at the luminous television screen. "The battleships, I figure, were replaced by other weapons. Aircraft carriers or whatever during the Second World War. The bomber, that is the manned bomber, isn't going to be *replaced* by anything. There are ICBMs and SLBMs and SLCMs and ALCMs —which we have agreed not to carry on airplanes any more—and all sorts of RPVs which are taking over the functions of the manned bomber, hell, they're taking over the functions of the manned *airplane*, but nobody wants to see them used." He took a sip of his drink.

"What do you mean?" asked Sheldon.

"The Age of Aquarius, man," replied the congressman. "Hey, Shelly, weren't you the one who told me that the Goddess was taking over, only not all at once?"

Sheldon settled back onto the couch. "So?"

"So the worshippers of the Sky Father have drawn the wagons in a circle around His temple, and they are going to fight rationality to the bitter end."

"Hey!" said Morton, "we just picked up a couple of swing precincts!" A general cheer went around the room.

"Well what are you going to do about it?" asked Sheldon.

Voss looked up from the TV screen. "About what?" he asked.

"About these nut cases that want to keep the Air Force."

Werner Voss sighed. "If I am lucky enough to eke out a win tonight, probably nothing. If I had recognized that reorganizing the Air Force was a religious issue, I would never have pushed it. You understand?"

His son-in-law shook his head, and Voss smiled. "No? Well, politics is nothing but a way to divvy up scarce resources without fighting. You compromise. You take half a loaf. You split the difference. That's what gives politicians a bad name among the True Believers, who get sold out on a regular basis."

"Hey," protested Sheldon, "they kept the Air Force in one big grubby piece and we didn't get diddley squat!"

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"Wrong," said Voss. "We aficionados of sweet reason got our half a loaf up front when the big bombers were scrapped. The other side wants to keep the Air Force that badly, they can have it."

"We took the 27th Precinct by 72 votes!" said Morgan raising his fist. "We're going to win this mother!"

"We're leading 50.2 to 49.8," said his wife.

"You're right!" Voss said, displaying an optimism he didn't feel. "We might even be able to claim victory at a decent hour!"

Chapter Seven

J. Harrison 'Harry' Riordan, Speaker of the House, ambled into Congressman Voss' office and eased his bulk into the big leather chair beside the mahogany rolltop desk. "Say, Werner," he said genially, "what's this about you putting an end to the new president's honeymoon?"

Werner looked up and took off his reading glasses. "Oh, hi, Harry. How are things?"

"They could be worse." A shrug. "They could be better, too, that's what I came to see you about."

"The presidential honeymoon?" Voss grinned. "After nine months you got to expect the delivery, right?"

"The president *has* delivered," said Riordan. "Establishing the National Pollution Authority was one biggie, the Kennedy-Mitchell Bank Reform Act was another." He sat back and folded his hands across his middle. "I should tell you there were others? You and I, we both know it. That man has done a job for the party and for the country, one hell of a job."

"I don't deny it," said Voss, "and they were jobs that badly needed to be done." The NPA had been controversial as well as expensive and the Bank Reform Act wouldn't have passed at all if the money hadn't already been spent. "But the man can't do it all at once."

"Yeah, yeah. You got to set priorities. We did the biggies first, and now we come back to clean up a few items that got overlooked in the press of business." Riordan shifted his bulk in the red leather chair. "I hear you cut the funding for the SDIO."

"The economy has been trying to get back to flat, OK? Revenues are down and the best we could do for them was 80 percent of last year," said the congressman. "Dave Kaplan came up to the Hill as the new Assistant Secretary of Defense to testify that 80 percent wouldn't do. He swore up and down it was so totally unsatisfactory that we might as well cut the whole program."

A shrug and a grunt. "So you took him at his word?"

"That was the consensus of the committee, Harry, talk to them about it."

"I got to hand it to you, Werner," said the Speaker, "you got your committee lined up with you on this one. I make it 12 to 2, with that asshole from Mississippi and his geek buddy from LaLa Land opposed." He sighed at the thought of them. "So it looks like you'll be reporting whatever bill you want onto the floor, right?"

"It looks that way," agreed the congressman, cautiously. This late in the game there weren't any easy choices left.

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"I'd like to talk you around to my point of view," said the Speaker. "Some of us, including the president, think that this country needs the SDI, and your bill. . . . Well hell, you can't be serious about defunding the SDIO, can you?"

"Some of us think that this country needs a little fiscal responsibility," said Voss. "Kaplan was right; 80 percent of last year won't keep the program alive. What should I cut to keep the SDI on track?"

"Ah hell, Werner, we don't need to cut anything. A little more red ink on top of what we have isn't going make that much difference." Riordan didn't really expect the suggestion to work, but he was obliged to make the offer. The Administration wanted some things worse than a balanced budget.

Voss smiled and turned his palms up. This was the latest reverberation of some fiercely partisan arguments, and he wasn't going to move. "Hey, I'm sorry, all right?"

"No problem, no problem," said the Speaker, meaning that he, personally, had no problem with Voss' intransigence. If there hadn't *been* a problem he wouldn't be sitting there. "You want to cut funds, we'll cut funds. Love will find a way, so they tell me."

"It wouldn't be the first time," conceded Voss. Over the past few years the budget process had been elaborately compartmented to prevent exactly the sleight of hand the Speaker was now contemplating.

"The best place to cut, Werner, the *only* place to cut is the Soviet-American Lunar Base. Those damned Russians have been bleeding us white on that boondoggle, and we need to turn it off so we can use the money for something constructive."

"That spending is obligated by a treaty," said Voss mildly. "I know it was the previous Administration and those crafty sons of bitches in the Other Body that did it, but Harrison, old buddy, we can't dishonor our sacred word just because it happens to be inconvenient."

A sigh. That one hadn't been very promising, either. "Where would *you* like to make the cut, Werner?"

"I have this dynamite report in the files somewhere. We could reorganize the Air Force and close down all sorts of Air Bases to save all sorts of money." Voss grinned. "I mean it's not like they still had manned bombers or anything. Nowadays the good old USAF is pretty much like the firemen on diesel engines, teetotally redundant."

"Hunh. What was it, three years ago you ran on that issue and won by thirteen votes on the recount?"

"Fifteen votes, Harry, it was thirteen votes in the election. Yeah, I got a bit of a burn there, but if you need money for the SDI that's where it's got to come from." A shrug and the faintest of smiles. "Too bad the president didn't take *that* up on his honeymoon."

The Speaker folded his arms. Reorganizing the Defense Department was like changing diapers on the Tar Baby. No way were you going to come out of it clean and he, himself, had told the new president to let it ride. Even in hindsight that had been good advice. Well, there was one more card he could play, though he was reluctant to do so. Kaplan had said it was up to him, but it would be the truly patriotic thing to do. "I had

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figured, you know, in a couple or three years to step down and settle in as Chairman of the Appropriations Committee. Eban Phillips, his wife has cancer, and he's been talking about packing it in. If I asked him, he'd do it now instead of later and just coast for one last term before calling it a career."

"After forty years?" Voss shook his head. After forty years one tended to confuse one's career with one's life. Well, maybe Riordan had something on Phillips. "That's twenty terms, counting the one rising on the calendar."

Riordan nodded in agreement. "That's about right," he said, and played his ace. "You pull the funds for SDIO, I'll step down as Speaker after the next election and support you for the job."

For a moment all that Werner Voss could think of was that Riordan was a man of his word, that the offer was real, that he, himself, might really become Speaker of the House. The prospect was dazzling, but then reality slowly asserted itself.

"Hey, Harry, that's a *real* interesting offer." The congressman got up and poured himself a cup of coffee, and a second for his guest, adding cream and two sugars as Riordan liked. Well hell, he thought sadly as he sat back down, it can't be done, it simply can't be done. "That's a great offer, actually, but I'm going to pass on it."

Now that's a relief, thought Riordan, but I made the offer in good faith. "You don't want to be Speaker of the House?"

"I'd love to be Speaker, OK? Face it, there isn't a chance in hell that I could make it after pushing through the funding for SDIO." His hand felt the heat from the coffee diffuse through the cool porcelain mug. "I mean, hell, the conservatives have already tagged me as wanting to fold the Air Force back into the Army and the Navy, and if I sell out on the SDIO the liberals won't support me, either. That leaves what, the moderates and the Black Caucus?"

Riordan took a sip of coffee. "Put like that, the numbers don't look real good," he conceded. Nevertheless, his offer had been sincere. Still, that was something he should have thought of. How had he missed it?

The congressman watched the steam rising from his mug and pondered his counteroffer. "Hey," he said at last, "we can put the 80 percent funding back in. If the president gets out in front and tackles the Defense Department reorganization, I'll approve a supplemental. Maybe."

"What do you mean, 'maybe'?"

"The money is there. If the president can shake it loose to use on the SDIO, he gets his supplemental. If he can't . . . Voss shrugged and took a sip of coffee.

"Dave Kaplan is going to be seriously pissed," said the speaker, "but I'll take it." He paused for a moment. He'd given Voss his best shot, because Kaplan and the president had played up to his patriotism. They wanted so ardently for SDI to continue, but Werner had a point. If the Administration needed something that badly, they should be willing to pay the price. Why had he missed what now seemed glaringly obvious? Because the president had promised to deliver the conservatives for whatever was needed? He felt a little chill running down his spine.

J. Harrison Riordan put his mug on the table. Six to five he was being used.

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So he'd have to study the matter. No point in getting mad, the thing to do was to get even. "Now whether the president is willing to dip into his political capital reorganizing Defense, who can say?" He held out his hand, and Voss shook it. "Deal?"

Voss smiled politely as he turned the problem over in his mind. The president wasn't going to tackle the issue, not if he had any sense. Those Air Force bases all over the country were just too much grandfathered pork to mess around with. So the SDI was going to wither on the vine? Maybe. The reason he'd cut funding for the SDIO now was to head off the supplemental request later in the year. This way there'd be an excuse to turn it down, a story to tell the media. "Deal," he said softly, "we'll give it a shot and see how it plays."

The Soviet-American Lunar Space Station hung in orbit, three fuel tanks from the shuttle set as the base of a gigantic tetrahedron, while the apex of the tetrahedron remained open for docking spaceships. The tanks themselves were covered with glittering black solar cells, and a spidery framework of aluminum girders supported an assortment of utilitarian devices. A voice came on, speaking in English with a simultaneous translation in Russian.

"This is Major Allison Fitzwilliams, at Lunar Base One," she said, sounding a little nervous, "where we have been preparing 10 1-kilogram slugs of 10 assorted materials. Most of the time required was not for extraction from the Lunar soil, but preparation of the samples, which were weighed to the nearest milligram and compressed in these round-bottomed steel tubes." There was a pause, as if she was listening to stage directions.

"Right." The picture suddenly shifted from the space station to inside the Lunar Base, a whitish room lit with fluorescent lights and lots of potted plants. Major Fitzwilliams turned to the camera. "For those in the audience who have not been following this story, the soil we are mining has a nominal 4.5 percent metallic iron content, which is easily amenable to magnetic separation techniques devised by the Space Institute of Leningrad, and this iron powder was sintered into rods and then drawn into wire which was formed into the steel tubes we are going to load into the mass driver. Can we shift to camera three?"

There was a several second pause, and then the view shifted to the Lunar surface. "This is the separation facility. On the far right, that loop is where we load the raw soil and grind it to 200 mesh, blowing the coarse stuff around and around with a little trickle of gas, and pulling the fines out as fast as we make them. Next to it is the magnetic separator where we pull out the iron. Next to that is the magnetic separation table. Just a tilted flat plate with a uniform magnetic field. Run the powder over it, it separates out into six main groups; a bigger table could resolve eleven or twelve, depending on the soil. The smaller table next to it is the electric separation table, same idea, only an electric field instead of a magnetic field. We separate each group into two or three subgroups, and after a couple or three passes wind up with 99 percent pure material, alumina 99.4, for ex-

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ample. Back to camera one, please." There was a flash of the space station, followed by Major Fitzwilliams in the Lunar Base. "I've been informed that the collecting ship is almost in position. Let me transfer you to the mass driver where this historic feat will be attempted."

The picture shifted, to the Lunar landscape in full daylight. An unimpressive apparatus was in the foreground, given scale by the footprints in the Lunar dust. It was partially hidden by rectilinear shadows and tied together by dusty looking cables. A man's voice came on, speaking Russian, also with simultaneous translation into English. "This is Captain Alexander I. Dunya of Irkutsk, with the crew at the magnetic cannon built by NASA scientists. The test firing earlier today was entirely satisfactory, and we are now going to inject into Lunar orbit the first industrial production from the Moon in the whole of human history." A space-suited figure appeared in the picture beside the surprisingly small apparatus and laid one gloved hand upon it. "The superconducting magnets of this cannon here will be kept far below the critical temperature by cooling with liquid nitrogen. The impetus to the slug comes from the discharge of solid state capacitors that are refilled by the trickle charge from our array of solar cells, so that we can fire one slug every 47.5 seconds," there was a pause. "Forty-seven point five milliseconds. The first clip of ten slugs," the figure pointed to an unimpressive part of the apparatus, "contains 200 mesh alumina, 99.42 percent pure. The second clip of ten slugs contains a locally prepared borosilicate glass, the third clip . . ." The slugs simply vanished, and the mass driver slid backward with the recoil.

The space-suited figure stepped over and loaded the second clip "The first ten slugs have been fired exactly at 1708:20 hours UMT." Another space-suited figure appeared, and inspected something at the foot of the mass driver, giving Dunya a thumbs up sign. "That was the NASA engineer Doctor Michael Lee. The magnetic cannon has returned to battery exactly where it belongs." There was a brief pause, and again the mass driver slid backwards with a smooth motion, as it recoiled along the rails holding it in alignment and returned to the mark. "The second clip of slugs was fired at 1708:58," said Dunya.

"This is boring," said Sheldon, getting up to stretch his legs. "Are you going to watch them shoot off the whole hundred slugs over the next however long it takes?"

"Sure," said Voss easily. "It's no worse than watching a basketball game where the teams rack up a total score of maybe a couple hundred points one or two points at a time. Hey, while you're up fix me another coffee."

His son-in-law obligingly picked the bottle of Cointreau off the credenza and poured a shot into the cup, topping it off with coffee from the stainless steel thermos. "Here you are," he said. "You really think this is interesting?"

"Thank you. Oh, yes! This is just absolutely fascinating," said Voss. "If this works . . ." He took a sip of the brandied coffee. "And it *is* working, knock wood, the Russians are going to want to build things in space. Big things. *Huge* things. Humongous crea-

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tions requiring enough funding to set the wheels of the Military Industrial Complex spinning in high gear."

"You mean the stock furniture of all those sci-fi stories you see on TV?"

"Ah, Sheldon, you have no sense of wonder. Poor nitty-gritty reality isn't up to those special effects Hollywood churns out, and you say reality is boring? Use your head!"

"So they shoot some stuff into orbit off the Moon. So what?"

"So what?" Voss was feeling far too mellow to be upset at the obtuseness of the father of his grandchildren. "Our poor over-engineered economy badly needs to produce more than can possibly be used, just to keep moving. The weapons they were building got to be so scary that we had to back off by popular demand, even though disarmament knocked the economy on its ass."

"What? You can't believe that garbage, Werner! Weapons production was *crippling* the economy!"

"It's all right," said Voss waving his hand dismissively. "I have been pickled in the bitter brine of economics, and what I tell you is that the economy is a living yeasty thing. Building weapons was what made the economy rise like dough!"

"That's crazy!" protested Sheldon.

"Hey, in space, whatever gets built, at whatever cost, is a capital investment that can be set against our ungodly, not to mention *appalling*, deficits here on Earth."

"You're drunk," said Sheldon.

The congressman took a deep breath, slowly released. "Surely not. I am merely elated at . . . at the technological panache displayed before us upon this very TV set. Think what happened when we *stopped* building weapons, eh? Poor, sad yeasties."

"Nu? How is *this* going to be an improvement?"

"The whole Solar System is a celestial sea of sugar solution, Shelly. A heavenly vat of—of—wort is the word I want?" He laughed delightedly. "Wort *is* the word I want! Wort prepared by the Divine Brewer to nourish the human spirit."

Sheldon looked at his father-in-law with a certain bemused affection. "Crazy as well as drunk," he said gently. "Look! They're tracking the collector ship!"

It was true. The collector ship was an ungainly pressure hull from which extended three long booms of almost mystical fragility. Two extended up into the orbit of the slugs to be collected, holding a kevlar net between them, while the third extended down towards the Lunar surface with its dynamic counterweight.

"This is Captain Peter Ivanovich Shuskin, from Newark, New Jersey," said an unmistakably American voice, followed by the simultaneous translation into Russian. "We are closing with the first group of ten slugs at a nominal 4.5 meters per second, a tad over ten miles an hour. We have radar contact." The net bulged, and bulged again as the ten slugs were caught one after another. "Beautiful, beautiful," said Shuskin, clearly elated, "we got them all! And here comes the second group!"

"Hey! All ri-ight!" yelled Voss.

The TV set cut to Moscow's Red Square, which was filled with people watching the big display sets in the

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afternoon sunlight. They were cheering, and waving and the church bells started to ring.

"What's all the shouting about here?" asked Mrs. Voss coming in from the dining room.

"I did it! I did it! I got the funding for the sucker and it works!"

"Sure, sure, Werner, honey. Just calm down. Now what was it you did?" He started to tell her, and her eyes glazed over, as they usually did when he talked about his work.

"That sounds really great," she said at last. It was what she always said when he displayed one of his unseemly enthusiasms. "But nobody will know you did it, will they?"

Werner Voss smiled happily. "The Goddess will know," he said and passed out on the couch. ■

FUTURES

(continued from page 93)

that he had to get through a series of computer game magazine interviews with comments about the cover art and screen shots.

Before letting him get back to work, I assured him that *Neuromancer* is actually a very entertaining game, with a good deal of wit that preserves the feeling of his novel.

While talking about the *Aliens III* script with Gibson, I asked him whether he'd seen the comic book series from Dark Horse Comics (2008 S.E. Monroe St., Milwaukie, OR 97222).

Aliens, with art by Mark A. Nelson and scripted by Mark Verheiden, has been a runaway best-seller for Dark Horse Comics. The early issues of the black and white comic have quickly become pricey collectors' items.

Gibson hadn't seen the series, but he understood that the comics would have made for some expensive movies. The continuing story features everything from full-blown aliens to the diminutive chest bursters that we've all grown to know and love.

But the comic can do things that would be next to impossible to accomplish in a film. We can, for example, be inside the mind of someone who is a host to an alien, lost in the swirl of his Earth-bound memories. There are glimpses of the alien's homeworld, whole herds of the creatures, and other bizarre predators on the planet. Picking up on the venal company man in the second film, the comic book series involves bringing a specimen back to Earth.

What makes the comic work so well is the tight script aided by detailed, moody artwork. The series is actually better, more powerful, in black and white than dappled with the bright colors normally seen in comic books.

Dark Horse also produces a number of other unusual and excellent titles. Paul Chadwick's *Concrete*, the poignant series about a man transformed, has won major comic book awards and Michael Gilbert's *Mr. Monster*, has taken a darker turn now that Doc Stearn's monster-hunting adventures are in black and white. These, with *Aliens*, are definitely worth searching for. ■

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the reference library

By Tom Easton

Cluster Command, David Drake and Bill Dietz, Baen, $3.50, 276 pp.
The Lantern of God, John Dalmas, Baen, $3.95, 407 p.
The Warrior Lives, Joel Rosenberg, NAL, $17.95, 260 pp.
Svaha, Charles de Lint, Ace, $3.50, 275 pp.
The Last Deathship off Antares, William John Watkins, Questar, $3.95, 204 pp.
The Third Eagle, R. A. McAvoy, Foundation/Doubleday, $18.95, 302 pp.
Shadows of the White Sun, Raymond Harris, Ace, $3.50, 240 pp.
Father to the Man, John Gribbin, TOR, $?, ? pp.

As I write these words, in January 1989, it has been two years since I last attended Boskone, the annual convention of the New England Science Fiction Society, now held in Springfield, MA. The next Boskone will be at the end of this month, and I'll be there. They've scheduled me to give a reading and to sit on two panels which promise a certain amount of rather squirmy fun. Imagine the situation: one of those panels is on "Reviewing the Reviewers" and will feature Algis Budrys, Peter Heck, and myself. The other, on "Walter Scott in a Space Suit: SF Adventures," will give me a chance to share tea and brickbats with David Drake, Tim Powers, and Joel Rosenberg.

As you know, I can get more than a little testy about the "pornography of violence" (might we call it C-onanism?). David Drake may therefore have it in for me. Tim Powers may not, for I have praised his work. Nor may Joel Rosenberg, for I have been known to say nice things about his adventures. But then again, as luck would have it, I recently received books by Drake and Rosenberg, and though I might not ordinarily have read either book, I did,

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just to be prepared for the panel. I also read a few other recent SF adventures.

Let's aggravate Drake first. **Cluster Command,** by Drake and "military sf author W. C. Dietz" (I quote Baen's puff sheet), is the second volume in the *Crisis of Empire* series. The series began when the Emperor's assassination "plunged the Galactic Empire into turmoil." There's an infant heir, but the Empire is falling apart. Loyalty to the greater good has been replaced by self-centered greed. But there remain a few stout and noble souls dedicated to maintaining order and civilization. One such is Anson Merikur, a commander promoted to general to accompany a new governor to a distant province and to see that the latter doesn't push this alien equality nonsense too far.

The series is touted as combining "action with a certain philosophical depth that is all too uncommon in modern science fiction, to say nothing of *military* science fiction."[1] That "depth" consists of saying, "Hey, guys. All them niggers out there are the underpinnings of civilization, and if we don't give 'em due credit, they're gonna kick our asses!" and adding a subtheme of, "Tut tut! Slavery is not nice!"

This is a message well worth the sending; in fact, it is one worth fighting for, one that can justify enthusiastic use of the military, and one whose espousal can well affirm a hero. Sadly, Drake and Dietz use it as an excuse to glorify violence in vast and loving detail. Anson Merikur proves a strong support for the governor, but only in a very physical way. He blows hell out of landscape, aliens, corrupt bureaucrats and gangsters, and more landscape. He's a real man, he is, and he proves his manly worth when his wife, the governor's niece, stripped of a beloved husband and forced to marry Merikur for political reasons, finally leaps into his bed.

Drake and Dietz handle the story fairly well. It moves rapidly, the reader cares about what is happening, and events converge on a reasonable ending, given the premise. But . . BUT . . . It doesn't help my good opinion when the authors are so guilty of sloppy thinking that they can say, on page one, "A row of three nictitating nostrils marched down the center of its face. . . ." The word "nictitate" refers only to eyelids and means "wink."[2] They chose the word for effect, I know, but the effect is so ludicrous that it destroys the drama of the scene. To misuse another word so sillily, we would have to refer to Anson Merikur "flaring his eyelids."

Then, too, Galactic Empires were shown long, long ago to be politically and socially ridiculous. And let's not even mention Barbie-doll women, *Star Wars* space battles, the hint of Horatio Hornblower—with a touch of James Bond—in Merikur and his exploits, or the sheer irrational stock villainy of planetary sterilization as appropriate punishment for an uprising of agricultural slaves. *Cluster Command* is an unrealistic assemblage of unimaginative, unoriginal, obsolete, off-the-shelf components.

And if you remove the gun-play, there remains no more than enough story for a short novelette. That is a clear indication that the violence is there mainly for marketing purposes. For pandering to adolescent bang-bang freaks. It's Conanism.

For those who wonder, no, I don't think such stories should be banned.

1. I can't help but think that this comment, *by the publisher,* reinforces my opinion of violent SF in general.

2. I checked the *Oxford English Dictionary.*

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There's a market for them, and we all benefit if those readers who love them are kept off the streets. But I will most definitely express my opinion of them. That is my job as your Reference Librarian.

It has an embarrassing moment in the "Foreward" whose first line is "Writers don't want glitches in their stories. . . ." but John Dalmas's **The Lantern of God** is nevertheless a more enjoyable piece of SF adventure than Drake's and Dietz's. It has plenty of action along with a little more than Drake and Dietz offer in the way of humane philosophy and a dose of wry satire, which always helps to make adventure seem more suitable for grownups.

Two millennia before the story, a cargo ship crashed on a world hitherto unsettled by humans. It dumped its cargo of pleasure droids, vat-grown programmable humans designed for hedonic expertise, on one continent and its true, free, natural humans on an archipelago. Now there are two civilizations on the two sites. One is industrialized, imperial, expansive—and human. The other, that of the droids, is less industrialized, kinder, philosophical, mystical, centered on the "worship" of Hrumm, conceptualized as a sort of playwright who hands each person his or her script at birth, designs the stage, and so on. Droids can be in touch with Hrumm through meditation (while, of course, repeating the mystic syllable, "Hrummmmmm"), and they can petition, in a way, for changes in role, script, and stage. Some of the droids can also read minds and so discover secret plans. At the same time, there are other sentients on this world, notably the sea serpents and the semi-humanoid sellsu, the people of the sea.

The imperial humans discover the peaceful humans and plot conquest. They begin building a fleet of 200 vessels that will carry soldiers and guns across the sea, and they send as vanguard a single ship. This ship drops ambassadors in the three droid nations and plots to make the most warlike of the three attack the most peaceful, Hrumma, thus weakening the droids for the invasion. But the ambassador to Hrumma, Elver Brokols, is seduced by the droids' way of life and helps them prepare for war by giving them the secret of gunpowder. Yet his help is only part, and perhaps a small part, of that victory. The droids of Hrumma have a knack for intrigue, they are in touch with Hrum, and serendipity—or the playwright—brings to their aid the sea serpents and the sellsu.

There is violence here, yes. But by and large it does not occupy center stage. Hrumma's victory is due to cleverness and a proper understanding of the nature of reality far more than to aggressiveness, muscular prowess, or bloody mindedness. *The Lantern of God* is SF adventure, yes. It is, if you wish, "Walter Scott in a space suit," with all the accompanying connotations of situations forceably devised to permit a host of anachronisms. But it's not Conanism. Take out the violence, and the novel remains a novel. It remains, in fact, the same novel of what would happen if a culture roughly equivalent to the England of the dawn of the industrial age met a culture roughly equivalent to, perhaps, Minoan Crete as often described in modern fantasy mythology.

Joel Rosenberg's **The Warrior Lives** lies somewhere between the Drake-Deitz and Dalmas books on the scale whose ends I have just pegged down.[3] It is the fifth installment in the *Guardians of the*

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Flame series, which "combines epic fantasy adventure with a twentieth-century sensibility through a band of dedicated fantasy-gamers who find themselves magically thrust into an all-too-real world of swords and sorcery" (from the publisher's puff sheet). I gather that in the earlier volumes, the gamers established their technological advantage (one, now known as the Engineer, reinvents the Colt Peacemaker for this volume), began their war with the Slavers Guild, befriended the telepathic dragon Ellegon, defeated the warring barons, and birthed the Empire. The Emperor, Karl Cullinane, leader of the gamers, married and had a son who turned coward the first time he saw action. As a result, Karl died in an explosion. So, perhaps, did his friends, Walter Slovotsky (a notable smart-ass) and the dwarf Ahira.

As this volume opens, all that is history. Karl's son, Jason, is the heir. He is also a callow, chuckleheaded youth whom Ellegon must constantly prompt and chide. But there are rumors—someone is slaughtering Slavers and leaving little calling cards saying "The Warrior Lives." Is Daddy alive? Ahira? Uncle Walter? Jason and a few others, eventually including Jane, Uncle Walter's nubile daughter, must investigate. If Daddy *et al.* do indeed live, they will do their damnedest to bring them home. In the process, Jason will grow up enough to affirm something I said last month, about how change cannot be successfully imposed by outsiders. To this, Rosenberg adds that growing up need not mean coming to terms with, or growing into, one's predestined occupation; when you've *really* caught on, you pass the job to the one best suited for it and find something more congenial for yourself.

Despite its sensible point, this one does lean toward the Conanistic. That is, perhaps, a hazard of all game-oriented novels, aimed as they are at people who love to play superhero. But the violence, though it is certainly there, does not dominate the story as it does in Drake's and Dietz's book. There is much more to engage the reader's attention—a world, realistically intricate (no matter what your opinion of dragons, dwarves, and elves, along with place-names that echo Tolkien), personal byplay and interplay, growth, and a modicum of wise advice to help the adolescent bang-bang freak find a path toward maturity.

Charles de Lint is renowned for his fantasies in which moderns confront faery, the realm of myth, legend, and history, or in which head confronts heart and the truer, nobler paths of existence. Now he gives us the same confrontations in science fiction instead of fantasy and proves that his skills are independent of the difference. And, yes, what he gives us is an SF adventure, complete with "Walter Scott" anachronisms.

The book is **Svaha,** a word de Lint says is an Amerindian word meaning "the time between seeing the lightning and hearing the thunder; a waiting for promises to be fulfilled." The time is our future, after an Amerindian musician had made it big and used his millions to educate a generation of Amerindian geniuses who, as lawyers, reclaimed the ancestral lands and, as scientists and engineers, developed a technology that permitted them to seal those lands off from the world as the Enclaves. The technology they do not

3. This is not to say that those books mark the scale's ultimate end-points. There are certainly more Conanistic books than Drake's and Dietz's—try the Watkins I review below—and less Conanistic books than Dalmas's.

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share. The Enclaves are for Amerindians only. The rest of the world can go to hell, and so it does.

The US and USSR virtually destroy western civilization, and Japan, China, and Korea move into the ruined lands, building a culture dominated by technocratic corporations, pervaded by organized crime (tongs, triads, and yakuzas), and surrounded by the squats, ruins inhabited by rats of all races. It's a dog-eat-dog world, strongly reminiscent of the world of cyber-punk, ruled by greed and envy and the yen for power, and the object of the grandest schemes is the Enclaves and their technology. An Enclave flyer is shot down. The flyer's computer chip, loaded with technological secrets, falls into outsider hands. An Enclave goes silent. And Gahzee Animiki-Waewidum must leave his Enclave—forever, for the pollutions, radiations, and plagues of the outer world will so contaminate him that he may never be allowed to return, unless he somehow manages to join the Twisted Hairs, those Amerindians of great wisdom who so control their bodies that they are immune to contamination. His mission is to destroy the flyer, recover the chip, and discover what has happened to the silent Enclave.

Immediately, he finds the spirits speaking to him, trying to tell him something of vital importance to him, his people, the world as a whole. He finds friends in the squats, while they and their friends are fighting their own battles. The battles overlap in ways that show ordinary people, oppressed, impoverished, ground down, struggling to discover and live by honor, while the "elite," who live only ostensibly by elaborate codes of honor, demonstrate their lack. The battles converge, the spirits speak again, and again, and Gahzee and his new friends seem destined to find and teach a new way of living in the world, a unifying way, an including—not excluding—way.

Svaha has love, mysticism, honor, martial arts, murder, more mysticism, blood, more love, superhero deeds, and high hopes. It's got it all, something for everyone, and it's very satisfying. I enjoyed it.

If you were fortunate enough to avoid William John Watkins's **The Last Deathship off Antares** when it was available, you missed one of the grandest possible Conanistic insults to a reader's intelligence. The premise is simple: The Evil Profiteers of human civilization have sent five million young men off to fight the alien Anties with equipment that won't work just so they can make billions selling that equipment to the government, which is in fact them. Not surprisingly, the troops get creamed, and the half-million survivors are imprisoned in fifty death ships (not just one, much less a last one), where they swiftly descend to demoralized, cannibalistic savagery until blind Driscoll starts kicking ass, organizing, and forging a *real* army that can beat the Anties hand to hand. The Anties, of course, go along with the hand-to-hand malarkey, hand over the fleet when defeated, and gracefully commit suicide. But Driscoll's heroes conquer all obstacles and return home to save humanity from self-serving greed forevermore.

It's bad enough that it's such simple-minded yard goods. It's bad enough that it's an idiot plot—one that works only because everyone involved has cheese for brains. But the real insult to the intelligence comes in when Watkins fails to take the trouble to check his bafflegab even minimally. In the death ships, the prisoners are fed by machines that convert a plasma into gruel. The plasma is generated by ionizing the atoms of suitable raw material, such as dead bodies

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and asteroids. And when the raw material runs out, the brave human heroes all nearly starve to death, until they realize what the problem is, learn to process asteroids, and fill up the larder. Unfortunately, they almost starve to death again on the way home, when there aren't any asteroids within reach.

Do I hear you saying, "Waaaiit a minute!" Well you might. A spaceship is, except for energy, a closed system, and every bit of raw material that goes in as food comes out as . . . more raw material. But if Watkins had admitted this little truth, he would have lost a good quarter of his story.

R. A. McAvoy moves from her fantasies of Renaissance lutenists and black dragons and Celtic legend to science fiction with **The Third Eagle.** And as you might expect, she is remarkably successful.

The Third Eagle is subtitled "Lessons Along a Minor String," reflecting the primary mode of ftl interstellar transportation in McAvoy's future world. That mode seems akin to that of San Francisco cable cars. The cars grab a cable with a gripper, and the cable then draws them down the track. McAvoy's spaceships "grab" a string in space, perhaps akin to the "strings" of present-day cosmologists, and ride it to their destination worlds. The strings form a galactic meshwork and therefore a great way to travel; they don't, of course, go near all worlds, so real estate is limited.

One world they do go near is Neunacht, poverty-stricken because it lacks a string station to attract commerce and prosperity. The planet is dominated by two groups, one of Chinese and one of Amerindian descent. Among the latter are the "Paints," martial arts specialists who serve the former group as bodyguards. The story's hero is Wanbli, a bright, eager Paint, so well skilled in his trade that he has already earned his third set of feather tattoos, or Eagle. He also itches with discontent, and when fate smiles, he seizes the opportunity to leave Neunacht and travel. He meets fellow travelers, and he learns that Neunacht's generations of payments toward a string station of its own have been wasted. He becomes acquainted with the rigors of a mining world, fulfills his dream of acting in McAvoy's Hollywood-equivalent, flees the consequences of accidental murder and becomes a whore, and befriends the "revivalists" who salvage old suspended-animation colony ships from their routes among the stars. Each step leads to the next, and in the end to a solution to many problems, among them Neunacht's.

Wanbli is a charming fellow and his story is an entertaining one. If it fails to convince, that is because McAvoy has let him succeed too easily, and perhaps because our senses of time and place are often lost in strange terminologies and too-slick elisions. Yet I do not hesitate to recommend it. McAvoy has captured with unusual insight certain essential consequences of any ftl technology that makes available only a limited number of worlds.

In **Shadows of the White Sun,** Raymond Harris offers us a distant future in whose past some humans left to wander the stars while others remained near Sol to build an advanced civilization homeostatically regulated by a vast artificial intelligence. Then the wanderers returned, as the Revenants, destroyed the blasphemously robotic Sol civilization and billions of people, settled into the few surviving space habitats, or Hypaethrons, and built a society of highly mannered preciosity, all ritual and tradition and status, reminiscent in ways of a space-going Gormenghast, or

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perhaps of Gene Wolfe.

In this setting, we meet Risha Skhorb, a sort of lady in waiting. She falls at first sight for Seren of murderous reputation and then, when he kills her best friend's husband and flees, accepts the mission of hunting him down and killing him. But Seren is on Veii (Venus). She must accept the aid of the android Firin, color her skin, learn the voodoo ways of the locals, explore the preindustrial and early industrial cultures of Veii, and gain and lose lovers. Eventually, she will get close to Seren, and then . . .

I don't generally care for preciosity of style or world, but I enjoyed this one. What struck me as its greatest weakness was Harris's choice to present it as the recorded brain-pickings of Risha by her master, Volshev. This robs the story of suspense and adds nothing essential in any way.

John Gribbin is best known as a science popularizer, but he can do a little more as well. Witness his novel, **Father to the Man.** As novels go, it isn't really much, for the plot would have fitted neatly into a short story. What makes it a book is the flashbacks; almost everything that happens is in the story's past. Furthermore, there's not much real action, and the characters are mere poses, emblems for villainy, selfishness, nobility, and curiosity. Yet the result is readable in a very *Analog*ian vein. The utter asininity of humanity gets its comeuppance quite nicely and evolution demonstrates that no, *it* won't ever learn either.

The situation: The world is in a worse mess than ever before. Rising sea levels, famines, dustbowls, plagues, and more seem inevitably to doom humanity. Meanwhile, in a small town in the hinterlands of England, there is an isolated manor house where lives a famous scientist who is something of a hermit. Now he's looking for a nanny, and when the girl arrives, she quickly and happily submerges herself in the manor's isolation. Eventually, Liz and Dick come to be on good terms, and he tells her the background.

That background is the bulk of the book: Years before, he had mastered the techniques of gene manipulation, won a Nobel Prize, and collected a pygmy chimp (the nearest of our relatives among the primates). At the time, his work attracted the fevered attention of fundamentalist fanatics, which led to the death of his lover and forced him out of his university post. Fortunately, his Nobel money and patent royalties sufficed to establish his own lab at the manor.

Meanwhile, a science journalist is looking at what old Nobelists are up to now. After a spot of investigation and cat burglary, she discovers this hairy kid locked up at the manor. He can't talk real well, but he's bright. He is, in fact, well above the human norm for intelligence. When Dick discovers the journalist, he tells all. And so do I, for the grand revelation is no surprise to the experienced reader: The kid is the end result of Dick's research; he had diddled an egg from his pygmy chimp and produced an ape-man whose intelligence permits the inference that nature, through evolution, has for ages frantically been trying to undo a serious mistake. With the ecological disaster so ominously looming throughout the book, nature seems on the verge of final success.

Exeunt omni.

The book's final scene is of bipedal apes scratching their heads as they face the lands at the feet of a new ice age's glaciers. Problem-solving intelligence dawns anew. Will our successors get it right this time around? Gribbin does not seem optimistic. ■

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SCIENCE FICTION
analog
SCIENCE FACT

CONGRATULATES THE WINNERS OF THE 1988 NEBULA AWARDS

given by the Science Fiction Writers of America

Best Novel

FALLING FREE

BY LOIS MCMASTER BUJOLD

(first published in *Analog*, December 1987-February 1988)

Best Novella

"THE LAST OF THE WINNEBAGOS"

BY CONNIE WILLIS

(*IAsfm*, July 1988)

Best Novelette

"SCHRÖDINGER'S KITTEN"

BY GEORGE ALEC EFFINGER

Best Short Story

"BIBLE STORIES FOR ADULTS, NO. 17: THE DELUGE"

BY JAMES MORROW

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brass tacks

Dear Dr. Schmidt,

I am writing in response to your January article, "Hypermedia and the Singularity." Overall, I thought the article was interesting, informative, and entertaining.

I believe the central theme of the article is that hypermedia offers great potential for solving many problems in information science. These problems include information portrayal, comprehension, access, storage, and manipulation (relationship). A key point of the article appears to be that hypermedia's great potential comes from its inherent ability to place *information space* at the hands of its users. With the information explosion, easy access to true information space would be a boon to researchers and their clients.

It is my opinion that a fundamental change must occur in our society's views toward information before hypermedia's real potential is realized. There are several reasons for this belief. First, the costs are too great. To be sure, the computer technology costs will be substantial. However, it is the cost of the manpower and talent to implement the link structures that is excessive. The fact is that information spaces already exist, to a degree. Examples encompass most of the commercially available computer database services, including abstraction services. While these examples are not true information spaces, they go far towards solving our information needs. The link structure used in most of these is keyword search. This method is very simple to implement, and is very flexible. The idea that the same flexibility will be available in hypermedia, but only relevant parts of a document are accessed, is difficult to envision. An important question to ask is why existing database services haven't improved over these simple methods.

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They have, in special cases like legal databases. In general, however, they have not because of cost. No one wants to pay more for something unless a better method is proven and the increased costs are justified.

My second reason is even more important. It has to do with the general idea of proprietary information. Proprietary information refers to any information in the possession of a person or company that is intentionally withheld from the public. This can include trade secrets, market research data, or virtually any form of closely held data. It also includes information that experts have that has not found its way into print.

The reasons why anyone would want access to proprietary information should be obvious. I make a big issue of it because this kind of information is high-value information. Often, but not always, it is high value because it is *not* disseminated. While the article includes mention of fees to access information, my point is that much of this information simply will not be sold, or would be sold only at the time when its value is greatly diminished.

In summary, I think that hypermedia's potential is not limited by technology, but rather by social and economic forces. The hypermedia information spaces made available in the next 10 to 15 years will likely be highly specialized, directed at very narrow segments of society. To most of society, hypermedia is not worth the cost.

JACK COURTNEY

Dayton, OH

The author replies . . .

I agree that society will have to change before hypermedia fulfills its *full* potential. But I also suspect that society and hypermedia will change hand in hand. Some organizations will adopt (and adapt to) hypermedia more quickly; those that adapt will make better decisions faster, and will outcompete those organizations that do not. Those that do not adapt to hypermedia will then either catch up or fold. This is the way new technology has infused society for centuries.

The one organization which is not under any competitive pressure to improve is the government. So the federal bureaucracy will be among the last systems to improve, and might easily take more than the 15 years you mentioned.

The cost of linking up existing documents would indeed be very great if we started today. For this reason, I expect to see hypermedia first appear where people are creating *new* information—at the time of creation, interlinking is much cheaper. Ten-person engineering teams may spearhead the transition, as hypermedia gives them a miraculous answer to a mundane problem: cross-referencing the requirements, the specification, the design, the test plan, and the test results, for the new products they implement.

Academic researchers will follow close behind, replacing their paper journals with small, specialized hypermedia spaces where scientists publish their newest experiments and ideas, while others refute those publications with directly linked counterpoints. Small corporations may be next, for whom the policy and procedure manual, when placed in information space, can grow into a body of corporate wisdom. Hypermedia will quickly impact anyone who uses a computer—and though that group is only a fraction of Americans, it still represents millions of people.

Also, remember that our information is growing exponentially. Simply putting new information into information space could, with surprising speed, put

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us in a position where all the old, unlinked information combined is merely a fraction of what is available on-line.

Keyword search is very simple to implement, but frankly it can never be more than a limited success. Recently, a researcher collected 13 newspaper write-ups at random from across the country about the Superbowl; none of the articles included the term "football." It is true that cost has prevented the development of superior systems —but not the obvious costs of hardware and link creation. The real problem has been the start-up costs of building really adequate tools. But determined people are working on those tools with feverish haste. For example, this year Xanadu will deliver the first hypermedia information server capable of managing information spaces that grow without bound. This will inaugurate a new era of heretofore impractical opportunities.

And of course there will still be proprietary information, though even the proprietary information will be maintained in private information spaces. Indeed, private information, like private property, is a good thing overall, though there are obvious drawbacks. Still, none of the information needed to cure the disease adrenoleukodystrophy (which was the example in the article) was proprietary; all that was needed was a series of links that would allow you to put the pieces together in less than three years.

So I consider it overly pessimistic to believe that only very narrow information spaces will be available years from now. Hypermedia might be a quiet revolution, but it will be a revolution nonetheless (did anyone notice when it became inconvenient to live without credit cards? Do you know what a massive infrastructure was required to make this difference that we hardly notice has changed our lives?).

Ironically, and quite by coincidence, six months after writing the article "Hypermedia and the Singularity," I became the director of Product Development for Xanadu. I have dedicated my life to proving you wrong. Please don't be too upset if I prove you wrong.

MARC STIEGLER

Dear Dr. Schmidt:

The articles by Stephen L. Gillett (Feb. 1989) and by G. Harry Stine and Wilfred C. Smith (Feb. 1988) that discussed the economic and technical aspects of large, high-risk ventures, such as manned space flight, were thought provoking. They prompted me to look up an old report dealing with the way practical development and application of advanced innovations occurs.

The TRACES study was carried out by a team in the physics division of IIT Research Institute. I worked there as manager of the Nuclear and Radiation Physics Section and knew some of the key team members. The TRACES study demonstrated how basic research is crucial to providing the understanding and advances in science and technology that lead to innovations that achieve widespread practical applications. The study focused on five recent (at that time, 1968) developments including the birth control pill, electron microscope and video tape recorder. In addition to providing strong support for basic research, the analysis of events leading to commercial exploitation resulted in the conclusion that the innovation must be demonstrated to be feasible (but not necessarily practical) about ten years before its general application. Roughly ten years before the demonstration of feasibility, the goal of achieving feasibility could be stated and the mission-oriented research needed could be defined. Ten years before practical application, 70%

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of the mission-oriented research and 90% of the basic research would have been completed, but 80% of the development would remain to be done.

Numerous examples can be cited in support of this generalization including television (I have rather good insight in that case; my father-in-law, A. V. Bedford, was one of the key inventor/engineers developing television at the RCA Princeton Laboratories in the 1930s until his retirement), lasers, integrated circuits, and nuclear power from fission.

Although it is often declared that taking the long view is anathema to industry, development of color television at RCA defies this rule. Bedford tells me that he worked almost exclusively on color television beginning in 1932. He regarded monochrome television as an accomplished fact except for engineering details. This was a case of an organization having a high level of confidence in the ultimate value and profitability of the innovation. (Sarnoff may have been the television equivalent of Flagler.) Similarly the commitment of various utilities to undertake the construction of three or four nuclear power plants suggests that a long-term viewpoint had been taken.

What is striking about all these cases is that once the technical feasibility has been demonstrated, practical exploitation occurs within about ten years even though a great deal of innovative development must occur in that time frame. It also appears that if practical exploitation has not occurred in about ten years it is unlikely to happen. An example of the latter case is the fuel cell. A large fuel cell power source (5 kw) was developed by F. T. Bacon in England about 1938. The Apollo cells were virtually the same design. A rather substantial R&D effort has not achieved a significantly improved fuel cell or led to a widespread application. I venture to predict that fuel cells will not be significant in the future.

Consider also the nuclear fusion reaction which was demonstrated almost 50 years ago (in the form of the D-D reaction with Van de Graaffs and other accelerators). Various confinement methods have been under study for at least 25 years. In this case feasibility has not been demonstrated and may never be.

Perhaps some key development or discovery is missing in the cases of fuel cells and fusion. But it is difficult to escape the conclusion that the key element may not exist. Are there counter examples; that is, an innovation in which a working prototype or engineering model was demonstrated but which saw no practical application until much later when a key development occurred?

The history of space flight fits the TRACES mold rather well, with most of the key technical requirements achieved and an engineering model (the V2) demonstrated in the 1940s. Much mission-oriented research and development occurred during the next 15 years, improving the technology and resulting in the first satellites (and ICBMs). At this point the last key technical event had occurred, the solid-state computer, and the concept of manned exploration in space was explicitly expressed and defined. TRACES style analysis suggests that most (80%?) of the development occurred in the nine years before the first Apollo mission. It seems quite clear that the technology for practical exploitation has been developed. But two decades have passed with only a spectacular but rather meaningless exhibition to point to. Can a negative conclusion regarding the prob-

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ability of the general application of manned space flight in the forseeable future be avoided?

ROBERT B. MOLER
12003 Bobwhite Drive
Catharpin, VA 22018

Dear Stan,

G. Harry Stine (March 1989) denounces those who warn of ozone depletion, the global greenhouse effect, or rapid extinction of species. According to Mr. Stine, these are imaginary problems, raised by the ignorant or duplicitous, creating apprehension in a public reeling from information overload. I beg to differ, and would like to direct *Analog* readers to some reliable sources that shoot holes in Mr. Stine's arguments that are, um, as big as the Antarctic ozone hole.

There has been significant ozone loss over mid-latitudes between 1969 and 1986, as well as unexpectedly large losses at high northern hemisphere latitudes during winter. The chemical reactions, observed in the Antarctic and in laboratory model systems, that unleash chlorine from anthropogenic compounds and convert it into forms capable of destroying ozone, have been detected in the Arctic stratosphere. In the Antarctic, destruction of stratospheric ozone may create a hole in the ozone layer because of a relatively long-lived stratospheric vortex; it is less likely that an Arctic ozone hole will form because the Arctic stratosphere has a less stable circulation pattern. Instead, one would expect ozone depletion to be spread over a wider geographic area in the Northern Hemisphere (*Science*, 24 February 1989, p. 1007-1008).

The last few years have been hot years in the United States. Very few atmospheric scientists would willingly attribute causation to the greenhouse effect; current models of future effects of the (completely noncontroversial) 25% increase in atmospheric CO_2 during the last century have significant uncertainties (interesting that in an area where scientists agree to disagree, Mr. Stine finds his own model's results incontrovertible). One should consider, however, that the potential for major societal upheaval may warrant implementing strategies to slow the rate of climatic change; whether the uncertainties are large enough to suggest delaying policy responses is not a scientific question per se, but a value judgment that requires informed public discussion (*Science*, February 10, 1989, pp.771-781).

The best informed biologists agree that we are about to witness an extinction of species that may rival those evidenced in the fossil record (i.e., the Cretaceous-Tertiary event). Habitats the world over are undergoing profound changes that may be irreversible: the rate of loss of species is now on the order of one every day. Mr. Stine would have us believe that because it is very difficult to kill a weed, it should be very easy to grow an orchard. Any gardener knows his mistake. Those interested may consult *Biodiversity* (E. O. Wilson, editor; National Academy Press, 1988).

One cannot make informed decisions about critical issues from bad information. Run, don't walk, to your local library!

PETER C. GRIFFITH, Ph.D.
Baltimore, MD

Dear Dr. Schmidt,

"Cap the Volcanoes" (March 1989) is a classic case of data masquerading as information. Harry Stine should do his homework better before accusing others of poor science or systems engineering.

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When Harry took chemistry, he should have learned the difference between a reactant and a catalyst. The *catalytic* action of chlorofluorocarbons allows a single ton to destroy more ozone than a million tons of *reactive* volcanic gasses. The effect on atmospheric ozone is solidly enough documented that DuPont is voluntarily phasing out CFCs. As inventors of the compounds with a financial interest in their production, they are unlikely to do this without compelling evidence.

The North Pole is at sea level in an ocean. The South Pole is in the middle of a continent that averages over a mile in altitude—so high that the stratosphere intersects the ground in midwinter. One can expect different effects in the two different systems. Where 100% ozone loss (not the natural 10% variation) has been seen in the Antarctic hole, a smaller effect occurs in the Arctic, but this has been well documented now. It is interesting that over ten years of good satellite data on atmospheric ozone has recently been discovered. The assumptions programmed into the retrieval system treated most of the data as instrument error, a fact not known until a ground-based scientist wondered why his colleagues hadn't seen the trend.

As pointed out in the paragraph on locusts, skin cancer doesn't matter much in the face of starvation. Excess UV has potential for causing major crop losses —which will affect all races, not just white folk.

In terms of other atmospheric gasses, small-scale doesn't mean no scale. Most engineering systems I am familiar with have significantly shorter lifetimes at 7% overload, some spectacularly so—7% extra shot, not powder, in a shotgun shell will probably blow up your shotgun.

In discussing extinction Stine mentioned the passenger pigeon, but failed to mention the Carolina parakeet, the California grizzly bear, and several others. Before DDT was banned in the U S we were well on the way to losing all the large fish-eating birds because their long food-chains caused extreme concentration of the DDT. The 50 species per century estimate is not an even comparison, either. This estimate is for all species—mites, locusts, snakes, frogs, fish—*all* species, not just large obvious ones. This comparison error might be expected from someone who can't tell a smallpox virus from a bacterium.

In terms of systems engineering, there are about five billion people living on a planet with a surface area of some 200 million square miles. Attempting to model an ecological system while ignoring 100+ pound omnivores at an average density of 25 per square mile is not likely to work.

Yes, we are going to live after all. This conclusion, however, makes the same error as those who point out that more people die of bee stings than snake or shark bite. Just because you ain't dead doesn't mean you ain't hurt bad. In many ways, we seem to be hurting the planet badly. If the only people who address these problems are "ecofreaks" who equate ecologically important with cute, and "hard-nosed engineers" who marshall their facts to sweep the problems under the rug, these problems will get much worse.

DWIGHT D. WAHLBERG
4953 West Point Loma Blvd
Apt. #1
San Diego, CA 92107

Dear Stan,

Maybe it's time for Harry Stine to get a new pair of glasses—*without* the blinders. I'm all in favor of taking a

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look at facts from an unusual angle, to put them in perspective. But in his March AV, Harry commits the unforgivable sin of stating as "fact" things that just ain't so (a ploy commonly used by creationists). Here are some facts for him to consider!

The reasons why the ozone hole appeared over the Antarctic and not the Arctic are well understood. They have to do with the extreme cold of the Antarctic stratosphere, and the stability of southern circumpolar winds. The way in which CFCs from the North get to Antarctica can be calculated by any competent atmospheric scientist—but we don't need the calculation, since the presence of CFCs there can be measured. Ozone depletion is *not* a problem only for pale-skinned folks—increased UV at ground level affects crops and livestock adversely, and even if we only think of effects on people, it causes eye cataracts in people of all skin colors. None of this evidence is hard to find—I enclose a copy of my book *The Hole in the Sky* for Harry's benefit, who has clearly been too busy to seek out such obscure publications as *Time* magazine lately (maybe he'd like to take up the points raised in the book in a later column).

My biggest worry is whether Harry has read anything since about 1980. He states as a "fact" that "the world is now in a cooling period following a warming phase that lasted from the middle of the 19th century until the 1960s." He might like to take a look at page 99 of my book. The figures there can now be updated: the six warmest years in the accurate historical record (which, agreed, only goes back a little over 100 years) were, in decreasing order, 1988, 1987, 1983, 1981, 1980 and 1976. *This* is a "cooling phase"? It isn't "one lone person" who Harry has never heard of (but who happens to be a real expert on the subject) who is sounding alarm bells about the greenhouse effect, but the whole community of atmospheric scientists that agrees that the world will warm faster over the next 50 years than at any time at least since the end of the latest ice age. And this is, indeed, supported by long-term climatic data. If Harry claims he has been unable to find that evidence, he can't have looked beyond the end of his own nose.

DR. JOHN GRIBBIN

●We live as we dream—alone.

Joseph Conrad

. . . unless you're lucky enough to be happily married.

John Hradsky

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a calendar of analog upcoming events

6-8 October
DRAGON CON (Atlanta SF conference) at *Omni International Hotel and Convention* Center. Guests of Honor—Anne McCaffrey, Wes Craven, Michael Whelan, and Andrew Greenberg. Registration—$30 until 15 September. Info: Dragon Con '89, Box 47696, Atlanta GA 30362. Include SASE 800-456-1162 for membership (MC/VISA).

13-15 October
ARMADILLOCON II (Austin area SF conference) at Wyndham South, Austin, Tex. Guest of Honor—Lewis Shiner; Fan Guest—Mike Glyer; Artist Guest—Teddy Harvia; Editor Guest—Pat LoBrutto; TM—Connie Willis. Registration—$15 until 2 April. Info: Box 9612, Austin TX 78766. (512)835-9304.

13-15 October
PINEKONE II/CANVENTION 9 (Ottawa SF conference combined with the Canadian national SF convention) at Skyline Hotel, Ottawa, Ont. SF Guest of Honour—Greg Bear; Fantasy Guest of Honour—Raymond E. Fiest; Art Guest of Honour—David A. Cherryh; Fan Guest of Honour—Michael Skeet. Registration—C$20/US$17 until 15 September, C$25/US$21 thereafter and at the door, supportingC$5. Attendance limited to 750. Info: Box 5368, Station F, Ottawa ON Canada K2C 3J1.

16-20 October
THIRD FESTIVAL OF SCIENCE-FICTION (academic SF conference) at University of Ottawa, Ottawa, Ont. Info: Denise Chénier-Ferguson, Socio-Cultural Activities, University of Ottawa, University Centre, 85 University, room 318, Ottawa ON Canada K1N 6N5. (613)564-5055.

20-22 October
BORÉAL II (Ottawa area francophone SF conference) at University of Ottawa, Ottawa, Ont. Awarding of the Prix Boréal. Registration—C$30 until 1 September, C$35 at the door (C$10 for student, free for under 15). Info: Boréal 11, % Jean-Louis Trudel, 410-2020 Jasmine Cresent, Gloucester ON Canada K1J 8K5 (613)749-8050.

20-22 October
NECRONOMICON '89 (Tampa area SF conference) at Ashley Plaza Holiday Inn, Tampa, Fla. Guests of Honor—George Alec Effinger and Tom Kidd. Registration—$15 until 15 September, $20 thereafter and at the door (one day memberships $8/day). Info: Necronomicon '89 Box 2076, Riverview FL 33569. (813)677-6347.

27-29 October
WORLD FANTASY CONVENTION at *Sheraton Hotel and Towers, Seattle*, Wash. Guests of Honor—Ursula K. Le Guin, Somtow Sucharitkul, Robert McCammon; TM—Ginjer Buchanan. Registration—$70 attending, $30 supporting until 1 May. Attendance is limited. Info: World Fantasy Con '89, Box 31815, Seattle WA 98103-1815.

23-27 August 1990
CONFICTION (48th World Science Fiction Convention) at Netherlands Congress Centre, The Hague, Netherlands. Guests of Honor—Joe Haldeman, Wolfgang Jeschke, Harry Harrison; Fan Guest of Honor—Andy Porter. Registration—$65 until 31 December 1989. Supporting—$28 until 31 December 1989. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: Worldcon 1990, Box 95370, 2509 CJ The Hague, Netherlands. Enclose sufficient International Reply Coupons for airmail response.

—Anthony Lewis

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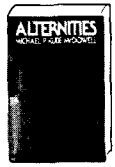

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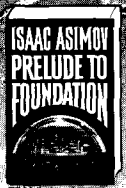

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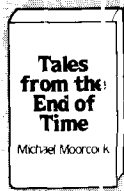

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